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RESEARCH AND DEVELOPMENT PROJECT PRIORITIZATION — COMPUTER MODEL

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U.S. ARMY MISSILE COMMAND
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is based upon research concerned with the aggregation of multiple lists of rank ordered research and development (R&D) projects or product requirements needing R&D. The resultant prioritized list serves as a basis for resource allocation to the R&D projects. The rank orders are ordinal and without feedback or strategy. The model and computer code use validated methods to compute the aggregation of up to 100 rank ordered lists of up to 100 alternatives. Final lists are computed by the Shannon,

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20. Borda, and Fuzzy set rank order methods. This report contains a complete computer code listing and map, and five representative examples of the variety of problems that can be computed.

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I. INTRODUCTION

A. Statement of the Problem

The problem addressed in this report and Dobbins (4,5) is to develop and demonstrate a methodology, with its associated computer model, that will acceptably transform several individual multiplecriteria rank ordered lists of research and development (R&D) projects into a single aggregated, prioritized rank ordered list to guide the investment of R&D resources. In addition, provisions are needed for the individual lists to be converted from various formats. Decision-maker and judge self-rating weighting methodologies are necessary. The methodology developed must be capable of aggregating, with reasonable effort, very long individual partial length and/or full length lists. Over fifty alternatives should be allowed in the full length lists. This report describes the computer model for the research.

B. Need for This Research Solution

The task of R&D management planning for high technology systems has become more difficult. The emphasis on coordination and communication between the management of major functional elements of high technology systems developmental organizations, both industrial and governmental, and the expanded usage of goal and objective planning methods have complicated the planning process. Situations have resulted where the planners in the R&D element receive many diverse priority lists of suggested future work or products from the other functional elements (i.e., marketing, field operations, production, and senior staffs) and from managers within the R&D organization. The prioritization criteria of interest to each contributing element differ as their functions and objectives differ. Therefore, the individual prioritizations will be based to some extent,

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upon the objective criteria and viewpoints of each element. The R&D element management must combine these lists into a usable list of prioritized R&D projects for their consideration in the allocation of discretionary R&D funds toward advancing the technology base of the enterprise.

As a specific example, the director of the US Army Missile Laboratory has such a planning need. Each year he selects and funds at least 100 R&D tasks with over $50 million. The Army policy of Single Program Element Funding (SPEF) gives to the laboratory director the final discretion to establish the most productive and best balanced program. The director is provided an abundance of advice from outside and within his laboratory. The advice is usually in the form of lists of R&D tasks or required products to which he should give higher priority and thereby funding. To advise the Army Missile Laboratory director, and his counterpart at other Army R&D laboratories, the user staff agencies of the Army, the Deputy Chief of Staff for Operation (DCSOP) and the Training and Doctrine Command (TRADOC), annually prepare documentations containing their priority rankings of potential, not yet developed military materiel. The TRADOC list gives a rank order number to each future system. The DCSOP document, called the Science and Technology Guide (STOG) groups the potential future materiel systems into unranked capability category classes of use; i.e., Air Defense, Close Combat, Fire Support, etc. Within each capability category the potential future systems are rank ordered. The laboratory directors must relate each R&D project technology task to the one or more potential future systems to which it could lead.

Three headquarters organizations, the Department of Defense (DOD), the Department of the Army (DA), and the Development and Readiness Command (DARCOM), as well as the US Congressional staff all have, on occasion, sent letters to the director recommending funding of certain selected tasks or groups of tasks within the director's SPEF program. Tri-Service special topic committees prepare, and often prioritize, lists of R&D project tasks which they recommend for increased funding. Army missile R&D technology often is included in the Tri-Service committee lists. The local commander's staff also provides a rank ordered list of systems to be supported by the laboratory's R&D technology efforts.

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Often the commander, who supervises the laboratory director, has a few R&D technology projects or potential applications that he believes should be given special attention and resources. Within the Army Missile Laboratory, task priority rankings are prepared by the director's staff and by subordinates of the directorates and officers of the laboratory. The laboratory director must allocate his discretionary funds to the R&D technology projects that will produce the most return on its investment by the Army and maintain the viability of the laboratory. He must give appropriate managerial, technical, and political weight to each of the recommendations of his advisors.

The preceding statement of need and the example can be resolved into the need for a methodology for aggregation of multiple criteria rank ordered priorities.

C. Scope of This Research

The research documented by this report and Dobbins (4,5) is based upon a comprehensive literature survey on the subject of social choice and majority rule methods that are applicable to the aggregation, without feedback, of multiple criteria rank ordered ordinal priorities. From this basis, the research determined and developed the specific majority rule methodology to aggregate the variety of rank ordered priority lists, as described previously, for R&D project priority determination. The chosen majority rule methodology is integrated by an aggregation logic model that satisfies the following requirements:

1) Aggregate rank ordered individual sublists which have any or all of the following features:

a) Complete length lists of up to 100 alternatives that rank all possible projects or requirements for products.

b) Reduced length lists (down to two alternatives) that rank less than the complete set of possible projects or requirements.

c) Transitive rank ordered sublists.

d) Weak ordered and/or strongly ordered ($X \geq Y$ and/or $X > Y$) sublists.

e) Categorized grouping sublists, where one of the following may occur:

(1) The projects are subdivided into categories. Then, within each category, the projects are ranked, but the categories may or may not be strongly ranked.

(2) The projects are subdivided into categories. Thus, the categories are ranked, but the projects within a category may or may not be strongly ranked.

f) Multiple sublists ranked in accordance with a common criteria or within individual criteria.

g) Sublists where the alternatives are ordinal ranked based upon various forms of cardinal utilities such as:

(1) Value estimates.

(2) The date that the usable materiel product from the R&D will be available.

2) Weight the importance and authenticity of each sublist during the aggregation process. The types of weighting mechanisms include the following:

a) Decision-maker weighting mechanisms to be applied to single alternative and/or to the sublists ranked by certain judges. The mechanisms will include multiplicative factors and exponential factors.

b) Judge self-expertise weighting where each judge will rate his own expertise on each alternative.

3) Analytically measure and statistically test the concordance of each sublist rank order and the consistency of the aggregate rank order.

The logic model was converted into a digital computer code to perform the preceding requirements for up to 100 rank order alternatives.

II. COMPUTER MODEL IMPLEMENTATION

This chapter gives a summary discussion of the computer code implementation of the ordinal rank order aggregation model described in Dobbins (4). The programming computer code structure is described and the output data format is briefly discussed. Extensive instructions and example computer problems were documented in detail.

A. Computer Model Development Overview

The aggregation of multiple criteria rank ordered priorities model presented in Dobbins (4) was implemented in Extended FORTRAN, Version 4, on the CDC CYBER 74. The computer used the NOS/BE executive program and has a 400,000 octal space capacity in its central memory. The computer facility is located in the Scientific and Engineering Division of the Management Information System Division of the US Army Missile Command (MICOM), Redstone Arsenal, Alabama.

The code was developed as an experimental program; therefore, achievement of its maximum matrix size was not a major consideration. The full potential for this priority rank order method can be realized when its matrix dimensions are re-optimized for the applied problem of R&D project prioritization. Instead of the present 100 x 100 matrix dimension, the more practical dimension may be on the order of 50 x 200 (50 judges with up to 200 alternatives).

The code design was modularized through the use of subprograms to facilitate phased development, refinements during research, verification, and validation. The thirteen subroutine programs will be described. Since the design goal of the model was to form and manipulate up to 100 x 100 element matrices and to aggregate one time sublists, the batch processing mode of computation was chosen as the most practical.

B. Computer Model Code Description

1. Overall Computer Model Steps

The computer model for this research requires large computer core storage space but operates very rapidly since it does not use iterative calculations. Further, the model's code design

emphasized flexibility of programming options as well as future operational flexibility to input and aggregate a wide variety of sublist priority order styles generated from many ranking criteria.

The flexibility of the model encompasses the wide variety of sublist formats that have been anticipated, such as requirements lists, expected operational dates, cardinal data, and the desire to develop methodology tools to permit exploration research in such areas as fuzzy set rank orders, preference scoring constants, and comparative aggregation methodologies. The comparative methodologies include the Borda, adjusted Borda, and the Shannon preference majority rule methods.

(a) Flow Diagram

Figure 1 contains a simplified model flow diagram. A most comprehensive module is the input subroutine. This block of the code inputs and stores the requirements-to-projects translation equivalency statements that are expected to be used for a number of runs. The input also reads and assigns the run and sublist control codes for actions such as the matrix scoring constants and the [illegible] type for the run. Typical sublist controls are alternative identifications and weights. The input also reads sublist data such as the ranks and self-evaluation values.

Found within the input subprogram, but functionally separate, is the conversion of the input sublist alternatives to a standard form. This includes conversion of cardinal scores alternatives to an ordinal ranking or the conversion of categorized alternatives into single rank ordered lists. Alternative is emphasized at this phase in the model, since the ranked elements can be either R&D projects or product requirements.

Where alternatives are product requirements, the next phase is to translate those sublists of rank ordered requirements into translative sublists of rank ordered R&D projects.

At the completion of the input, conversion, and translation phase, all sublists are ready to enter the matrix aggregation in a standard form of transitive rank ordered lists of R&D projects.

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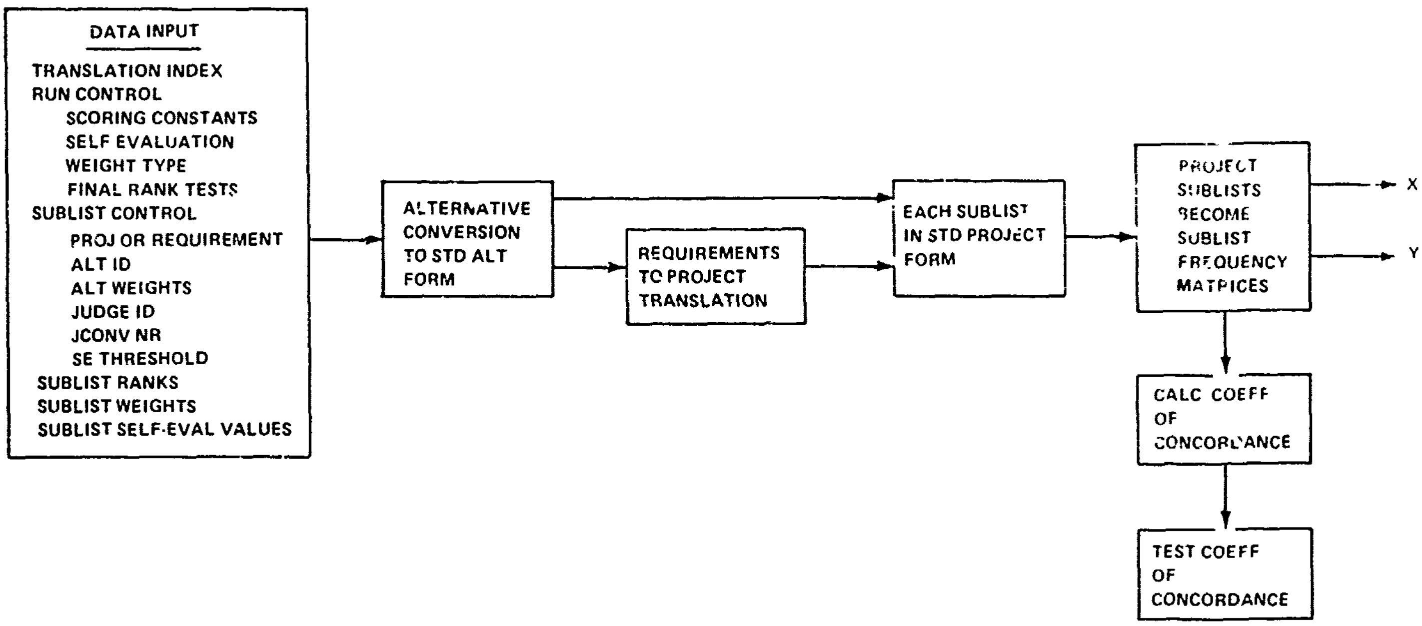

Figure 1. Simplified model flow diagram.

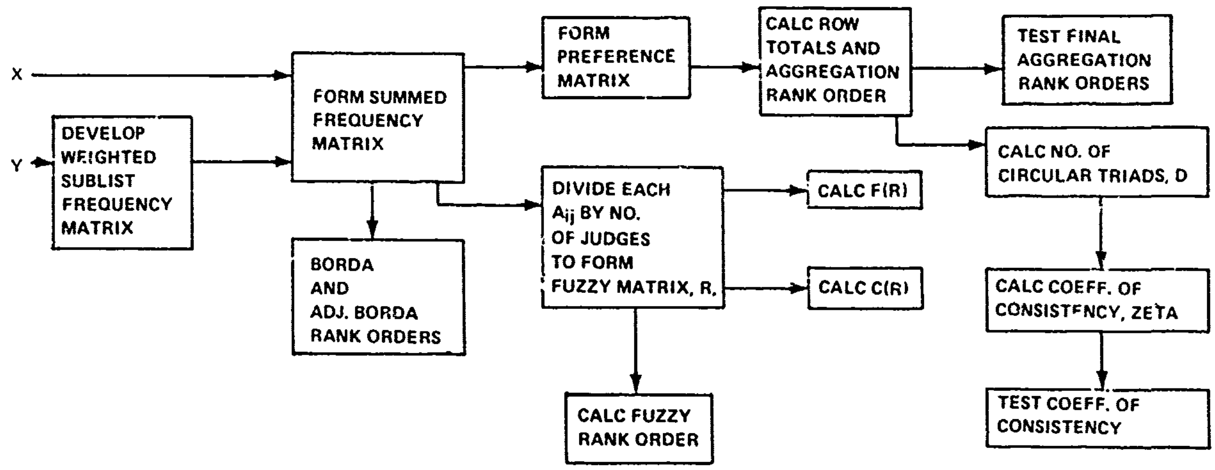

Figure 1. (Concluded).

Initially in this second phase, the sublists become sublist frequency matrices scored by the chosen constants. The same standardized sublists are used to calculate and test the statistical significance of the coefficient of concordance.

If weighting and/or judge self-evaluation are included for the run, the sublist matrix elements are next normalized by multiplication by four and then weighted. At this phase, the judge self-evaluation factors become another multiplicative weight.

The sublist matrix elements, either all weighted or unweighted, are summed into the summed frequency matrix which contains the sum of votes, or weighted votes, that each alternative received when paired against each other alternative. If there is no judge indifference, the sum of the values in each row element become the Borda count for the row (project). With or without judge indifference, the sum of the row element values minus the sum of the column element values is the adjusted Borda count. The model rank orders these counts into the Borda and adjusted Borda rank orders.

The summed frequency matrix element values, divided by the number of judges, becomes the fuzzy matrix, R. From R, the model calculates the fuzzy measures, F(R) and C(R), and the fuzzy rank order.

The comparison of the complement paired element values in the summed frequency matrix is the basis for element values in the preference matrix. The preference matrix assigns scores to projects for the number of majority comparisons they win, tie, or lose. The sum of the row element values provides the aggregation count for each project. The model rank orders this count into the aggregation rank order.

The preference row counts also provide the inputs for the calculation of the number of circular triads, D, and the coefficient of consistency, zeta. The model tests the statistical significance of zeta.

Last, the model can compare any chosen combinations of the final rank orders (Borda, adjusted Borda, fuzzy, or preference) then determine and test the Kendall's coefficient of concordance for these rank orders.

The appendix contains a more comprehensive model functional flow diagram which contains major decision logic nodes.

(b) Subroutine Programs

The appendix contains the listing with definitions of key terms for the aggregation of multiple criteria rank order priorities computer code, developed for the dissertation research. The code structure diagrammed in Figure 2 consists of the main program and thirteen subroutine program modules as follows:

(1) Main Program - DOBBINS - The main program coordinates all mainstream processing of rank orders through the model. It calls subroutines in the proper sequence for calculations in a given run based on user and model provided controls and data. It writes only the summed frequency matrix and the Borda-type counts and rank orders.

(2) Subroutine INPUT - The subroutine reads and/or coordinates the input controls and data. The subroutine also converts the sublist alternative data to the standard ordinal rank order format. INPUT reads the run controls and the sublist controls. It coordinates the calling of subroutine PRAM which reads sublist ranks, weights, and self-evaluation data. The self-evaluation rating full scales are converted to 0 to 1 and the specified sublist conversions JCONV 2 to 12 are performed in INPUT. This subroutine applies the self-evaluation threshold and checks all subroutines for completion. Finally it stores the converted, unweighted standard form sublists of ranked alternatives.

(3) Subroutine PRAM - This is library subroutine to enter floating point data in free format form where precise formats are not practical. In this computer model, PRAM is used to enter the sublist rank data and the self-evaluation data.

(4) Subroutine REQUIRE - This subroutine receives converted requirements sublists from INPUT. It compares each sublist to the translation index that has been sorted and arranged by requirement name. REQUIRE then extracts the projects that match the requirement in the sublist. A project's rank order is built by insertion of the group

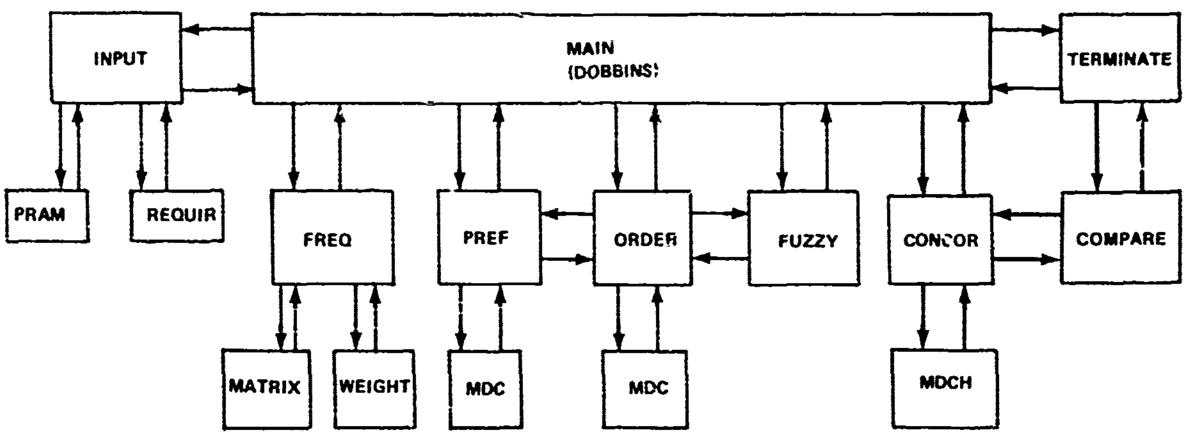

Figure 2. Subroutine module network.

of projects for each requirement. REQUIRE purges duplications from the raw projects rank order. The transitive project sublist is returned to INPUT.

(5) Subroutine FREQ - This subroutine coordinates the placement of the sublists into sublist frequency matrices and the weighting of the frequency matrix elements. It further applies the self-evaluation values to the frequency matrix elements and writes the sublist self-evaluation frequency matrix.

(6) Subroutine MATRIX - This subroutine forms and writes the sublist frequency matrix for each sublist. The matrices are formed using the specified matrix scoring constants.

(7) Subroutine WEIGHT - This subroutine applies the specified weighting to each sublist frequency matrix element and writes the weighted sublist frequency matrix. Before any weights are applied, WEIGHT multiplies all sublist matrix elements by four.

(8) Subroutine PREF - This subroutine forms and writes the preference matrix, calculates the number of circular triads, D, and the coefficient of consistency, zeta, and statistically tests zeta. The subroutine also calculates the bracket and average values for D and zeta when fractional sums occur in the preference matrix rows. All D, zeta, and test results are written by this subroutine. The matrix is formed using the specified matrix scoring constants.

(9) Subroutine MDCH - This subroutine is an International Mathematical and Statistical Libraries (IMSL) program which is used for the chi-squared probability statistical tests of the Kendall coefficient of concordance and the coefficient of consistency. MDCH automatically changes to use the normal distribution approximation, Z, for the high degrees of freedom with the chi-square statistic. ($df \geq 30$)

(10) Subroutine ORDER - This subroutine converts a list of values for a set of

alternatives into an ordinal rank ordered list of the alternative identifications. ORDER writes the final rank order list.

(11) Subroutine FUZZY - This subroutine calculates the fuzzy matrix, the measures F(R) and C(R), and writes the Fuzzy project scores. This subroutine coordinates the forming and writing of the Fuzzy rank order list.

(12) Subroutine CONCOR - This subroutine calculates, statistically tests, and writes the results of the coefficient of concordance for the standard sublists. CONCOR also calculates and writes the intermediate concordance variables such as the mean and the sum of the squares of the deviations from the mean.

(13) Subroutine COMPARE - This subroutine takes the final aggregate rank orders from the BORDA, ADJUSTED BORDA, PREFERENCE, and, if available, FUZZY methods and compares them two at a time. The pairs of aggregated lists are sent to CONCOR and evaluated, then return to COMPARE. When the last pair is evaluated COMPARE returns to the main, DOBBINS, and the program terminates.

2. Input to the Computer Model

(a) Overview

The inputs to this computer code have been kept relatively simple compared to the complexity of the model. Inputs are the run controls and alternative names, the ranking and rating data entered in free form.

(b) Option Control

Besides the alternative names and numbers, the first set of cards (one card per alternative) contain the alternative weight factors and category for that alternative. The second type of single control card has integer numerical digits to designate the type of weighting technique (one through eight), whether the sublists should be completed, the type of matrix scoring constants for both the frequency and preference matrices, the

self-evaluation control for weighting or weighting and threshold elimination, and the self-evaluation scale limit value. The third type control card [one card per judge sublist] identifies the judge, designates the alternative conversion type, and gives the judge weight factors. The appendix specifies input data format in greater detail.

(c) Data

The sublist ranks and the self-evaluation ratings are input [illegible] separate sets of free format cards. For the subl[illegible] rank set, the sequence of alternative numbers indi[illegible]s the preference order with minus signs used to indicate equality or indifference. Each sublist ends with an asterisk. The sublist self-evaluation ratings are listed on their cards in an order corresponding to the lexigraphic order of the alternatives' identification numbers (1, 2, 3, ..., etc,).

3. Output from the Computer Model

(a) Aggregation Rank Orders

The primary output of the computer model for this research is the aggregated rank ordered list of R&D projects. The Snannon majority method produces the baseline aggregation rank order list for the model. For comparative purposes, the model also produces the Borda-type rank orders and the Fuzzy matrix rank order. To permit run-by-run verification and analysis of each aggregation rank order, the model outputs the inputs, the sublist matrices (basic, and if appropriate, the weighted and/or self-evaluation matrices) and the sum of the rows for the summed, Fuzzy, and preference matrices.

(b) Evaluation Results

The model further provides the results of the evaluation of the input sublists and the aggregation rank orders. It computes, statistically tests, and prints the major steps of the Kendall coefficient of concordance (7) evaluation of the standardized input sublists. The statistical tests conclude with statements as to whether the input rank orders are consistent at the 0.05 and 0.01 significance levels. Again, for verification and analysis of each evaluation, the model provides the rank array, the alternative sums, means, the sum of the squared deviations, the tied ranking factor, and the coefficient of concordance.

The model also performs up to six Kendall's coefficient of concordance analyses of all two-rank order combinations of the four aggregation rank orders, i.e., Shannon versus Fuzzy, Shannon versus Borda, adjusted Borda versus Fuzzy, etc. The output details are the same as those for the coefficient of concordance evaluation for the input sublists. These evaluation data provide a measure of the agreement between the various final aggregations.

The other evaluation parameters are Kendall's number of circular triads, D, and the coefficient of consistency, zeta, which evaluate the cyclicity characteristics of the Shannon aggregation rank order. The statistical tests determine if the tested rank order could have occurred by chance, instead of by a somewhat consistent preference method.

The appendix contains a program list and samples of the output from the computer model.

C. Sublist Conversion to Standard Format

The computer model converts input sublist rank orders of alternatives from various forms into the standard format for the frequency matrices. Secondly, if the sublist alternatives are product requirements, the model translates those sublists into standard form project rank orders.

1. Conversion

The model subroutine INPUT converts each sublist alternatives to standard format. The sublist input control must specify which conversion

method is appropriate for that sublist's rank data. The conversion command codes are as follows:

a. JCONVØ or JCONV1 - These codes mean the sublist input is in standard complete form and requires no conversion nor synthetic completion.

b) JCONV2 - This code means the sublist input is in the standard, but incomplete, form and requires no synthetic completion.

c) JCONV3 - This code means the sublist input is in the standard, but incomplete, form and requires completion. For JCONV3, the input rank order is moved to the left for insertion of all omitted alternatives at a lower, and equal, rank on the right end of the list. In summary, JCONV3 says the input list should be completed and that is higher ranked than all of the omitted alternatives.

d) JCONV4 - This code means the sublist input is in the standard, but incomplete, form and requires completion. For JCONV4, the input rank order is moved to the right for insertion of all omitted alternatives at a higher, and equal, rank on the left end of the list. In summary, JCONV4 says that the input list should be completed, and that it is lower ranked than all of the omitted alternatives.

e) JCONV5 - This code means the input sublist is cardinally scored in some fashion and that the alternatives should be ordinally ranked in descending order of the cardinal scores, i.e., best alternative has highest score.

f) JCONV6 - This code means the input sublist is cardinally scored in some fashion and that the alternatives should be ordinally ranked in ascending order of the cardinal scores i.e., largest valued alternative has the lowest score.

g) JCONV7 - This code means that two incomplete sublists exist which are related by a single key alternative in the primary list. For JCONV7, the secondary list is inserted and ranked immediately below the key alternative. After being combined, all lower or equal rank duplicate alternatives are purged. In summary, JCONV7 says that the secondary list is lower ranked than all alternatives

in the primary list that are above the key alternative.

h) JCONV8 - This code is the reverse of JCONV7. For JCONV8, the secondary list is inserted and ranked immediately above the key alternative in the primary list. Again, after being combined, all lower or equal duplicate alternatives are purged. In summary, JCONV8 says that the secondary list is higher ranked than all alternatives in the primary list that are below the key.

i) JCONV9 - This code applies to combining two-tier inputs into a single standard list. For JCONV9, both the upper tier categories and the lower tier alternatives are ranked. The model places the alternatives, in order, for the highest category above the alternatives for the second highest category above the alternatives for the second highest category, etc.

j) JCONV10 - This code again applies to combining two-tier inputs into a single standard list. For JCONV10, the upper tier categories are unranked, but the lower tier alternatives are ranked. The model considers the categories equal and places the highest alternative from the first category equal to the highest alternative from the second category. The next lower rank order level would be the second place alternative from one category equal to the second place alternative from another category.

k) JCONV11 - For this two-tier case, the upper tier categories are ranked, but the lower tier alternatives are unranked. The model considers the alternatives within each category to be equal. It places all the alternatives from the highest category first and equal above the equal alternatives from the second place category, etc.

l) JCONV12 - For this two-tier case, neither the upper tier nor the lower tier alternatives are ranked. The model places all alternatives as equal in the single sublist.

2. Translations - Requirements to Projects

If the input alternatives in the converted sublists represent product requirements, the model will translate these requirement lists into project lists. A set of translation index equivalencies must be separately input into the model. An equivalency statement would say, for example, that Project A is equivalent to Requirement 3, Project D is equivalent to Requirement 6, and that Project A is equivalent to Requirement 6. It would be anticipated that the translation index would change infrequently and could be prepared for input only once for a series of aggregation studies.

D. Matrix and Rank Order Formation

Once the sublist rank orders are in standardized project alternative formats, the computer model forms each into a sublist frequency matrix that indicates which project is preferred over each other project by pair comparisons. The summed frequency matrix is the matrix element addition of the sublist frequency matrices.

The preference matrix is formed from the paired comparisons of each of the summed frequency matrix element values.

The project scores are computed from the row, and column, if appropriate, sums of the elements of the summed frequency matrix and the preference matrix. The model then places that project with the highest score highest in the rank order and repeats the search for each equal or lower scored project.

E. Ancillary Processes

1. Weighting

(a) Decision-Maker Methods

The model input weighting functions are input as a control code and weighting factor data codes. The weighting factors are the weights applied to each alternative, WHI, and the weights applied to each judge, WHJ. If Alternative a has a WHI value other than 1, every time Alternative a appears in a sublist frequency matrix, it will be weighted by the factor WHI. If Judge 2 has a WHJ

value other than 1, every other alternative in Judge 2's sublist will be weighted by the factor WHJ. If Alternative a is in Judge 2's sublist, it will be dual-weighted by WHI and WHJ.

The weighting control code, NWT, is input as a control integer number, zero to eight. The weight control codes have the following meaning:

1) NWT = 0 - Apply no weights.

2) NWT = 1 - The alternative weight, WHI, is multiplied by the alternative score times four in the sublist frequency matrix.

3) NWT = 2 - The judge weight, WHJ, and the alternative weight, WHJ, are multiplied by the alternative score times four in the sublist frequency matrix.

4) NWT = 3 - The alternative score times four, in the sublist frequency matrix is taken to the WHI exponent.

5) NWT = 4 - The alternative score times four, in the sublist frequency matrix is taken to the WHI times WHJ exponent.

6) NWT = 5 - The alternative score times four, in the sublist frequency matrix is multiplied by the alternative weight, WHI, and is taken to the WHJ exponent.

7) NWT = 6 - The alternative score times four, in the sublist frequency matrix is multiplied by the judge weight, WHJ, and is taken to the WHI exponent.

8) NWT = 7 - The alternative weight, WHJ, and the judge weight, WHJ, are added to the alternative score times four, in the sublist frequency matrix.

9) NWT = 8 - The weighted score is the natural logarithm of the product of the alternative times four, in the sublist frequency

matrix, the alternative weight, WHI, and the judge weight, WHJ.

(b) Judge Self-Evaluation Methods

The judge self-evaluation (JSE) methodology is implemented as a weighting scheme. JSE is controlled by the MATR code in the control card, as follows:

1) MATR = 0 - No JSE.

2) MATR = 1 - The JSE factors are applied to all ranked alternatives. No threshold is applied.

3) MATR = 2 - The JSE factors are applied to all ranked alternatives. A threshold is applied that purges all ranked alternatives with JSE ratings below the threshold value which is input as a THLD value.

The JSE ratings, applied as any real number, are input for each judge's alternatives by the set of Number 3 data cards which are free format. The ISEM value, input with the judge's identification data, is the maximum value that that judge could assign for his JSE rating scale. Through the ISEM values, each judge's JSE ratings are scaled onto a zero to one scale. The scaled JSE ratings are multiplied by the alternative scores in each sublist frequency matrix, as were the multiplicative weights. The judge's self-evaluation sublists are summed into the summed frequency matrix and the aggregation continues as if the sublist were decision-maker weighted.

The application of JSE ratings prohibits dependable synthetic completion of sublists because any conceivable synthetic JSE rating completion method would probably result in values that were inconsistent with those applied by the judge's inputs.

2. Preference Scoring Constants

The preference scoring constants to be used [0, 0.5, 1] or [-1, 0, 1] for the frequency and preference matrices are designated by the values of the control card inputs for NPTYP1 and NPTYP2. NPTYP1, for the frequency matrix scoring constants,

can have control values of zero or one. NPTYP2, for the preference matrix constants, can also be zero or one. These values for NPTYP1 or NPTYP2 mean

0 : [0, 0.5, 1]

1 : [-1, 0, 1]

The model applies the NPTYP1 and NPTYP2 values in the frequency and preference matrix subroutines.

3. Fuzzy Set Rank Order

No controls are necessary to obtain a Fuzzy rank order and its evaluation. But if the standard project sublists are incomplete, or if JSE and/or weighting are used, the Fuzzy computations are bypassed. The Fuzzy matrix is applicable for this research purpose only if the cell values for each x,y plus the cell values for each y,x are equal to one. The Fuzzy set matrix, rank order, and evaluation computations were described in Dobbins (4).

4. Evaluation Techniques

No controls are necessary to obtain evaluation of the input rank orders. In each run where the standard project sublists are complete, the Kendall's coefficient of concordance computation and tests are made. For every run the Kendall's number of circular triads and the coefficient of consistency are calculated and tested for the Shannon aggregation rank order. The final aggregation rank orders are comparatively evaluated by the coefficient of concordance method for each combination of final rank orders that is calculated by the model. The evaluation and test calculation techniques are summarized in the remaining paragraphs of this chapter.

The evaluation methods selected had to accommodate the several ($n \geq 3$) rank orders being aggregated, and the several aggregated rank order outputs from the different methods. Three Kendall methods were chosen for the evaluations:

a) Kendall's coefficient of concordance test

b) Kendall's circular triads analysis

c) Kendall's rank order consistency analysis and test.

The implementation of each into the model will be discussed in the next sections.

(a) Coefficient of Concordance Test

1) The Coefficient - Kendall's coefficient of concordance, W, was chosen as a measure of the relation among several rankings ($n > 3$) of alternatives. Arrow (1) says Kendall's statistic W may be used in the same situation in which Friedman's two way analysis of variance by ranks test statistic is available. Conover (3) said further that Kendall's W was probably intended as a measure of agreement in rankings rather than as a test statistic. This interpretation of Kendall's W coincides with the needs of this research model. The coefficient of concordance is applied in two ways. First, the method measures the agreement among the judges' sublists. Second, the method measures the agreement between combinations of aggregated rank orders obtained with different majority rule methods, i.e., Borda, Adjusted Borda, Fuzzy Set, and Shannon. The first application provides an indication of the agreement and divergence of the judges, while the second application provides a measure of the agreement between the final rank orders results, not just the winning alternative, from different majority rule methods. The Kendall's W method is limited to sets of rank orders that have the same length. Therefore, if partial and complete rank orders are aggregated together, a Kendall's W measurement cannot be calculated unless the incomplete rank orders are synthetically completed.

The rationale of the coefficient of concordance, W, is to serve as an index of the divergence of the actual agreement shown in the data from the most perfect agreement, Seigel (8).

To compute W, first array the rank orders in a table with M judges ranks listed in rows and

alternatives in columns. Next, find the sum of the ranks R_j, in each alternative column. The mean sum $\bar{R}_j$, is calculated by summing R_j values for all alternatives and then dividing by the number N, of different alternatives. Next, the deviation from the mean $|R_j - \bar{R}_j|$ is calculated for each alternative. Next the square of these R_j deviations are summed into an S value. S, therefore, is stated as

$$S = \sum_{j=1}^{N} \left[R_j - \frac{\Sigma R_j}{N} \right]^2 .$$

Tied alternatives in a ranking cause complications in Kendall's W computations. Excess numbers of tied ranks in an aggregation tend to depress the value of W. A correction is available, Kendall (7), to adjust this effect of excessive tied rankings.

To correct for tied ranks, first count the number of observations, t, in a group, g, of alternatives tied for a given rank level in each judge's sublist. Second, the T factor is calculated for each row, i, (judge's sublist) by the equation

$$T_i = \frac{\Sigma_{t,g} (t^3 - t)}{12}$$

where $\Sigma_{t,g}$ means to sum the $(t^3 - t)$ term for each tied group in the judge's sublist. Third, the T_i values are summed into a total for all rank orders in the problem by

$$\sum_{i=1}^{M} T_i$$

The tied ranking correction and the squared sum of deviations, S, are used in the coefficient of concordance, W, equation

$$W = \frac{S}{\left(\frac{1}{12}\right) M^2 (N^3 - N) - M \sum_{i=1}^{M} T}$$

where M is the number of judges and N is the number of alternatives. If there are no significant tied ranks, W is

$$W = \frac{S}{\left(\frac{1}{12}\right) M^2 (N^3 - N)} \quad .$$

2) The Test - Kendall (7) developed methods and special small N value probability tables to test the hypothesis H_O; there is perfect disagreement between the judges (there is no concordance between judges). The test for H_O varies depending on the value of N (the number of alternatives). W varies from zero to one. It will be one when the ranks assigned by each judge are exactly the same as those by the other judges. W will be zero when there is maximum disagreement among the judges.

For N (number of alternatives) between three and seven inclusive, and M (judges) $\leq$ 20, the significance of concordance under H_O is tested by the S, the sum of the squared deviations, test in the model by using Table 1, which is a combination and extension of two Kendall tables (7), (Appendix Tables 5 and 6).

If the aggregation model calculated values for S exceeds the tabulated critical values for each level of significance (0.01 and 0.05), then it is concluded that agreement is significant.

For the degree of freedom, ν, less than or equal to 30, which includes N (number of alternatives) greater than seven and less than 31 and M (number of judges) greater than two, the significance under H_O is tested by the corrected W, the coefficient of concordance, and the χ^2_{cal} (calculated chi-square) where

$$\chi^2_{cal} = M(N - 1)\ W$$

with the degrees of freedom, $\nu = N - 1$. The χ^2_{cal} value is tested against χ^2_{CR} (critical χ^2), in (7) (Appendix Table 8), on page 191 in Kendall (7). The 0.01 and 0.05 significance levels of χ^2_{CR} are read from the P = 0.01 and P = 0.05 columns, respectively. If χ^2_{CAL} is greater than χ^2_{CR}, then H_O can be rejected, and it can be concluded that there is

TABLE 1. SIGNIFICANT POINTS OF S (FOR THE COEFFICIENT OF CONCORDANCE W)

M	N				
	3	4	5	6	7
Values at 0.05 Level of Significance					
2	7.8	18.5	37	58	97
3	18	35	64.4	103.9	157.3
4	25	49.5	88.4	143.3	217.0
5	31	62.6	112.3	182.4	276.2
6	38	75.7	136.1	221.4	335.2
8	48.1	101.7	183.7	299.0	453.1
9	54.0	114.8	207.4	337.8	512.
10	60.0	127.8	231.2	376.7	571.0
12	71.9	153.8	278.6	454.2	688.6
14	83.8	179.9	326.1	531.7	806.1
15	89.8	192.9	349.8	570.5	864.9
16	95.8	205.9	373.5	609.3	923.7
18	107.7	232.	421.	686.8	1041.2
20	119.7	258.0	468.5	764.4	1158.7

M	N				
	3	4	5	6	7
Values at 0.01 Level of Significance					
2	7.9	19	39	68	104
3	19	42	75.6	122.8	185.6
4	31	61.4	109.3	176.2	265.0
5	41	80.5	142.8	229.4	343.8
6	52	99.5	176.1	282.4	422.6
8	66.8	137.4	242.7	388.3	579.9
9	75.9	156.4	275.9	441.2	658.4
10	85.1	175.3	309.1	494.0	737.0
12	103.5	213.1	375.5	599.7	894.
14	121.9	250.9	441.9	705.4	1051.
15	131.0	269.8	475.2	758.	1129.5
16	140.2	288.7	508.4	863.8	1208.
18	158.6	326.4	574.8	916.6	1364.9
20	177.0	364.2	641.2	1022.2	1521.9

Note: Modified Kendall's Appendix Table 6 (7)

significant agreemeht among the judges at the levels selected (0.01 and 0.05).

For N between three and seven inclusive, and M greater than 20, the model used the same χ^2_{CAL} and χ^2_{CR} method just described.

For degree of freedom, ν, greater than 30 ($N > 31$) and all values of M greater than two, the significance under H_O is tested by the tie corrected W, the coefficient of concordance, χ^2_{CAL} shown previously, and the Z_{CAL} value tested against the Z in the normal distribution. First calculate

$$Z_{CAL} = \sqrt{2\chi^2_{CAL}} - \sqrt{2\nu - 1}$$

with the degrees of freedom, $\nu = N - 1$. The Z_{CAL} value is tested against Appendix Table A, page 247, in Seigel (8). P_{CR} values are 0.01 and 0.05 for the respective significance values. If P_{CAL} is less than or equal to P_{CR}, then H_O can be rejected, and it may be concluded that there is significant agreement among the judges at the levels selected (0.01 and 0.05). The model for this aggregation research selects the type of concordance statistical test based upon the values of M and N.

(b) Circular Triads Analysis

Kendall's circular triads analysis (7,21) was chosen as a measure of the acyclicity of the pair majorities in the preference matrix of the Shannon method. In preference matrices of more than three alternatives, it is possible to have the majority preferences of three alternatives aligned to be circular triads. For example, Kendall presents a preference matrix example ((21) page 145) which would have a Shannon majority rule aggregate rank order of A = C > B = E = F > D. When analyzed internally, it has five circular trials: ACDA, ABDA, AEDA, AFDA, and BEFB. Triads are counted because, for example, any circular tetrads must contain two circular triads. Kendall further proved that the maximum possible number of circular triads is

$$\frac{(N^3 - N)}{24} \text{ if N (number of alternatives) is odd,}$$

and it is

$$\frac{(N^3 - 4N)}{24} \text{ if N is even.}$$

The minimum number of triads is zero. He further proved that the maximum and minimum number of triads can be attained by arrangement of preferences. Kendall's equation for d, the number of circular triads in a preference matrix, consists of the terms N (number of alternatives) and a_i, the sum of the rows of the preference matrix. The equation for d is

$$d = \frac{1}{6} N (N - 1) (N - 2) - \frac{1}{2} \sum_{i=1}^{N} a_i (a_i - 1).$$

The Kendall derivation of d is based on rank orders without tied pairs (indifference). When a preference matrix has tied pairs, it causes pairs of a_i terms that have fractions. The fractions are always one-half, i.e., 1.5, 3.5, 6.5, 7.5. When tied pairs exist, the sum of the a_i is not necessarily

$$\binom{N}{2} = \binom{N}{2,\ N-2} = \frac{N!}{2!\ (N-2)!} = \frac{N\ (N-1)}{2}$$

which is the sum of a_i for integer valued, no tied pairs. preference matrices. To resolve this problem, the model for this research brackets the possible d values if fractional pairs of a_i's exist. The steps of the d bracketing method are:

Step 1: Arrange the a_i row totals in order of their value.

Step 2: Count the number of fractional a_i row totals.

Step 3: Round the upper one-half of each pair of the fractional a_i values upward to their next larger integer values.

Step 4: Round the lower one-half of each pair of fractional a_i values downward to their next smaller integer.

Step 5: Verify that the sum of the rounded a_i's equals 1/2 N (N - 1).

Step 6: Calculate a d value for this rounded set of a_i values. Label this the "lower d" since

it will give the lower value of zeta, the coefficient of consistency yet to be described.

Step 7: Return to the ordered unrounded a_i's and round the upper one-half of eacn pair of the fractional a_i values downward to their next smaller integer values.

Step 8: Round the lower one-half of each pair of the fractional a_i values upward to their next larger integer values.

Step 9: Verify that the sum of the second rounded a_i's equals $1/2\ N\ (N - 1)$.

Step 10: Calculate d value for this second rounded set of a_i values and label this the "upper d".

Step 11: Average the lower d and upper d to form an approximate d for the matrix with the tied pairs.

(c) Coefficient of Consistency

Kendall (7) extended the number of circular triad analyses to a coefficient of consistency, zeta, which relates the calculated number of circular triads, d, to the maximum number possible: $1/24\ (N^3 - N)$ if N odd or $1/24\ (N^3 - 4N)$ if N is even. The equation for the coefficient of consistency is

$$\text{zeta} = \begin{cases} 1 - \dfrac{24d}{N^3 - N}, & \text{if N is odd} \\ 1 - \dfrac{24d}{N^3 - 4N}, & \text{if N is even.} \end{cases}$$

For no inconsistencies (no circular triads), zeta is unity. As the number of circular triads increases, zeta approaches zero.

To test Kendall's coefficient of consistency, special tables modified from Svestka (9) and Kendall (7), χ^2 tables, and normal distribution Z tables will be used. The hypothesis tested is H_o, zeta is not significant and there is no consistency in the

aggregated rank order. The test for H_o again varies depending on the value of N (the number of alternatives). Begin with a calculated zeta.

For N (number of alternatives) less than or equal to nine, use Table 2 which is modified from Appendix Table A-3 in Kendall (7) and Svestka (9). For an N value, enter the table with a zeta to obtain a P_{CAL} value. If the P_{CAL} equals or exceeds each level of significance (0.01 and 0.05), then H_o is accepted and the rank order is not consistent. If each level of significance is greater than P_{CAL}, H_o is rejected and it is concluded the rank order is significantly consistent.

For N (number of alternatives) $\geq$ 10 and $\leq$ 23, the significance under H_o is tested by a χ_{CAL} (calculated chi-square) test, where

$$\chi^2_{CAL} = \frac{8}{N-4}\left\{\frac{1}{4}\ {}^{N}_{3} - d + \frac{1}{2}\right\} + \nu$$

where the degrees of freedom, ν, are

$$\nu = \frac{N\ (N-1)(N-2)}{(N-4)^2}$$

and

$$C^N_3 = \frac{N!}{3!\ (N-3)!} = \frac{N\ (N-1)(N-2)}{6}$$

The χ^2_{CAL} value is tested against χ^2_{CR} in Appendix Table 8, page 191, in Kendall (7). The 0.05 and 0.01 significance levels of χ^2_{CR} are read from the P = 0.95 and P = 0.99 columns, respectively. If χ^2_{CR} is $\geq \chi^2_{CAL}$, then accept H_o that the rank order is not consistent, but if χ^2_{CR} is $< \chi^2_{CAL}$, then reject H_o and it can be concluded that there is significant consistency among the final rank order.

For degrees of freedom, ν, greater than 30 (N>23), the significance under H_o is tested using the χ^2_{CAL}, shown above, and the Z_{CAL} value tested against the Z in the normal distribution. First calculate

TABLE 2. PROBABILITIES FOR CONSISTENCY

COEFFICIENT, ZETA, FOR N = 3 THROUGH 9

H_o: zeta is <u>not</u> significant. If $P \geq a$, accept H_o, if $a > P$, reject H_o.

N = 3		N = 5		N = 7	
Zeta	P	Zeta	P	Zeta	P
0	1.000	0	1.000	0	1.000
1.000	0	0.200	0.703	0.072	0.964
		0.400	0.469	0.143	0.853
		0.600	0.234	0.214	0.737
		0.800	0.117	0.286	0.553
		1.000	0	0.357	0.420
				0.429	0.287
				0.500	0.198
				0.572	0.112
				0.643	0.069
				0.715	0.033
				0.787	0.017
				0.858	0.006
				0.929	0.002
				1.000	0.000

TABLE 2. (CONTINUED)

N = 4		N = 6	
Zeta	P	Zeta	P
0	0.625	0	1.000
0.500	0.375	0.125	0.773
1.000	0	0.250	0.509
		0.375	0.398
		0.500	0.208
		0.625	0.120
		0.750	0.051
		0.875	0.022
		1.000	0.000

TABLE 2. (CONTINUED)

N = 8		N - 8	
Zeta	P	Zeta	P
0	1.000	0.550	0.063
0.050	0.949	0.600	0.037
0.100	0.859	0.650	0.023
0.150	0.768	0.700	0.011
0.200	0.629	0.750	0.0064
0.250	0.520	0.800	0.0028
0.300	0.390	0.850	0.0013
0.350	0.299	0.900	0.0004
0.400	0.208	0.950	0.0001
0.450	0.153	1.000	0.0000
0.500	0.094		

TABLE 2. (CONCLUDED)

N = 9		N = 9	
Zeta	P	Zeta	P
0	1.000	0.533	0.045
0.033	0.9976	0.566	0.030
0.066	0.980	0.600	0.019
0.100	0.945	0.633	0.012
0.133	0.882	0.666	0.007
0.166	0.803	0.700	0.0042
0.200	0.702	0.733	0.0023
0.233	0.611	0.766	0.0013
0.266	0.498	0.800	0.0006
0.300	0.408	0.833	0.0003
0.333	0.320	0.866	0.0001
0.366	0.248	0.900	0.0001
0.400	0.183	0.933	0.0001
0.433	0.138	0.966	0.0001
0.466	0.095	1.000	0.0000
0.500	0.067		

$$Z = \sqrt{2\chi^2_{CAL}} - \sqrt{2v - 1} \text{ with the degree of freedom,}$$

$$v = \frac{N(N - 1)(N - 2)}{(N - 4)^2}$$

The Z_{CAL} value is tested against Appendix Table A, page 247, in Seigel (9). P_{CAL} values are found from the table for the Z_{CAL} values. The P_{CR} values are 0.01 and 0.05 for the chosen significance levels. If $P_{CAL} \leq P_{CR}$, then accept H_o and conclude that there is no significant consistency. If $P_{CAL} > P_{CR}$ then reject H_o and conclude that there is significant consistency. The model selects the correct test based upon the values of N.

III. COMPUTER MODEL VERIFICATION AND VALIDATION

This chapter contains the verification and validation of the computer model, including sample numerical validation problems.

A. Verification

1. Model Design and Test

Verification that the rank order aggregation computer model was implemented properly in the computer code was accomplished through the modular design of the code, unit testing of each subroutine, phased buildup of the computer model with tests after each phase is added, running a series of test problems for comparisons of computer model output with hand calculated results, and a final exercise of all options in the program.

Extensive model validation in the sense of running large aggregation rank ordered priorities problems was not possible due to the lack of available problems with known solutions using any of the four majority rank methods that are built into the computer model. Validation of portions of the model options against moderate sized known problems with solutions from the literature was accomplished. Some of the special features of this model, such as weighting, fuzzy rank orders, and judge self-evaluation were validated by calculated extensions from matrix aggregation methods confirmed against the literature.

2. Verification Demonstration

The computer model's flexibility was verified and demonstrated through the exercise of most of the computation options for a single set of complete sublist rank orders, a single set of partial sublist rank orders, a set of alternative and judge weights, and a set of self-evaluation ratings. The data input reflected five judges' (one through five) evaluation of seven alternatives (A through G). The judges' rank order sublists for the complete set of data areas follows:

Judge 1:

Alternative Order:

A > B > C > D > E > F > G

Alternative Index Order:

1 > 2 > 3 > 4 > 5 > 6 > 7

Judge 2:

Alternative Order:

G > B = D > A = C > F > E

Alternative Index Order:

7 > 2 = 4 > 1 = 3 > 6 > 5

Judge 3:

Alternative Order:

C > D = E > F = G > A > B

Alternative Index Order:

3 > 4 = 5 > 6 = 7 > 1 > 2

Judge 4:

Alternative Order:

A > G > B = F > C = D > E

Alternative Index Order:

1 > 7 > 2 = 6 > 3 = 4 > 5

Judge 5:

Alternative Order:

D > C > B > A = E > G > F

Alternative Index Order:

4 > 3 > 2 > 1 = 5 > 7 > 6

The decision-maker weights are as follows:

Judge Weights:

Judge 1: 1

Judge 2: 1

Judge 3: 4

Judge 4: 2

Judge 5: 1

Alternative Weights:

Alternative A (1): 2

Alternative B (2): 2

Alternative C (3): 4

Alternative D (4): 1

Alternative E (5): 1

Alternative F (6): 4

Alternative G (7): 1

The judges' self-evaluation ratings for these alternatives are listed below. Since the JSE scales differ for each judge, the upper limit of each scale, where the rating is units, is also given as the ISEM value:

Judge

Alternative	1	2	3	4	5
A	2	1	4	6	5
B	8	4	2	10	4
C	4	2	4	10	5
D	6	3	3	6	5
E	2	1	4	8	1
F	10	5	4	7	5
G	8	4	3	5	4
Limit (ISEM)	10	5	4	10	5

The judges' rank order sublists for the incomplete set of data are listed below. The judges' sublists for Judges 1, 4, and 5 were complete and were the same values as for the complete set of data. The incomplete sublists are:

Judge 2:

Alternative Order:

G > B = D > A > F > E

Alternative Index Order:

7 > 2 = 4 > 1 > 6 > 5

Judge 3:

Alternative Order:

E > F = G

Alternative Index Order:

5 > 6 = 7

All weights are the same for the alternatives for the complete and incomplete sublists data..

The model options exercised for the complete sublist demonstration problem are the eight decision-maker weight types (NWT 1 through 8), the two judge self-evaluation types JSE M = 1 (without threshold) and JSE M = 2 (with threshold), the matrix scoring constants (0 for 0, 1/2, 1 and 1 for -1, 0, 1), and combinations thereof. The model outputs compared consisted of the adjusted Borda rank order, the

Preference rank order, coefficient of consistency data, and coefficient of concordance data for the adjusted Borda rank order compared to the Preference rank order. The consistency data included the number of circular triads (d), the consistency coefficient (zeta), yes-no (Y, N) statements as to whether the consistency coefficient was significant at the 5 percent and 1 percent levels. The results concordance data are the mean (M), the square of the deviations (S), the Kendall's concorance values (W), and yes-no (Y, N) statements as to whether the adjusted Borda and the Preference aggregation orders are in significant concordance to the 5 percent and 1 percent levels. Since most runs were weighted or self-evaluated, Fuzzy comparative rank order data were unavailable. Table 3 presents the results for the complete sublists. The first line of each table uses > and = symbols. After the first line, commas represent the greater than (>) symbols. For this example, the resulting rank orders vary widely for each model parameter option except the changes in scoring constants. For qualitative verification, each run should be compared with the basic run (C1). For example, Run C2 uses multiplicative alternative weighting (WI). For this example, alternatives C (3) and F (6) are weighted heaviest, followed by alternatives A (1) and B (2), followed by the remaining alternatives. This explains how the 3 and 6 alternatives move to higher rank positions in Run C2 as compared to Run C1. Similar logic can explain the differences in each run from C1. The consistency data show that the multiplicative and exponential weight types tend to bring the Borda count matrix aggregation closer in consistency to the majority preference matrix aggregation order. The model options exercised for the partial sublists demonstration problem are the same as those for the complete sublists data plus the two sublist completion options, JCONV 3 and JCONV 4. The model output types for the partial data are the same as for the complete data. Table 3 presents these results for the partial sublists. Run-by-run comparative analysis shows that the options are reasonable.

B. Model Validation

Computer model validation was accomplished by comparing results of the computer model to results for examples found in the literature. The literature often gave only winners for the method

TABLE 3. VERIFICATION DEMONSTRATION RESULTS COMPLETE SUBLISTS

Run No.	Score Const	Parameter Varied	Adj Borda Rank Order	Preference Rank Order	Consistency				Results Concordance				
					D	Zeta	5%	1%	M	S	W	5%	1%
C 1	0,0	BASIC	4 > 3 > 1 > 2 > 7 > 5 > 6	4 > 1 > 3 > 2 > 5 = 7 > 6	4.5	0.68	N	N	8	108.5	0.95	Y	Y
C 2	0,0	NWT = 1(WI)	3, 1, 2, 4, 6, 7, 5	3, 1, 2, 4 = 6, 5, 7	0	1	Y	Y	8	108.5	0.98	Y	Y
C 3	0,0	NWT = 2(WI-WJ)	3, 6, 1, 4, 2, 7, 5	3, 6, 1, 4, 2, 5 = 7	2.5	0.92	Y	N	8	110.5	1.0	Y	Y
C 4	0,0	NWT = 3(EXP WI)	3, 6, 1, 2, 4, 7, 5	3, 6, 1, 2, 4, 5, 7	0	1	Y	Y	8	110	0.99	Y	Y
C 5	0,0	NWT = 4(EXP(WI-WJ))	3, 6, 4, 7, 5, 1, 2	3, 6, 1, 2 = 4, 5 = 7	2	0.86	Y	Y	8	84	0.76	N	N
C 6	0,0	NWT = 5(WI EXP WJ)	3, 6, 4, 5, 7, 1, 2	3, 4, 5, 6 7, 1, 2	0	1	Y	Y	8	106	0.95	Y	Y
C 7	0,0	NWT = 6(WJ EXP WI)	3, 6, 4, 7, 1, 2, 5	3, 6, 1, 2, 4, 5, 7	0	1	Y	Y	8	90	0.80	N	N
C 8	0,0	NWT = 7(+WI+WJ)	3, 1, 4, 2, 7, 6, 5	3, 1 = 2 = 4, 5 = 7, 6	5	0.64	N	N	8	101.5	0.95	Y	N
C 9	0,0	NWT = 8(log(WI-WJ))	3, 1, 4, 2, 7, 6, 5	3, 1 = 4, 2, 7, 5 = 6	5	0.64	N	N	8	109	0.99	Y	Y
C10	0,0	JSE (M = 1)	4, 3, 2, 7, 1, 6, 5	4, 3, 1, 7, 2, 6, 5	0	1	Y	Y	8	104	0.93	Y	N
C11	0,0	JSE (M = 2)	4, 3, 1, 2, 5, 7, 6	4, 3, 1, 2 = 5 = 7, 6	4	0.71	Y	N	8	106	0.98	Y	Y
C12	1,1	BASIC	4, 3, 1, 2, 7, 5, 6	4, 1, 3, 2, 5 = 7, 6	4.5	0.68	N	N	8	108.5	0.98	Y	Y
C13	1,1	JSE (M = 1)	3, 4, 2, 1, 7, 5, 6	3, 4, 1, 2 = 5 = 7, 6	1	0.93	Y	Y	8	102	0.94	Y	N
C14	1,1	JSE (M = 2)	3, 4, 2, 1, 7, 5, 6	3, 4, 1, 2, 7, 5, 6	3.5	0.75	Y	N	8	110	0.98	Y	Y
C15	1,1	NWT = 3(EXP WI)	3, 6, 1, 2, 4, 7, 5	3, 6, 1, 2, 4, 5, 6	0	1	Y	Y	8	110	0.98	Y	Y
C16	1,1	NWT = 4(EXP(WI-WJ))	3, 6, 7, 4, 5, 1, 2	3, 5, 1, 2, 4, 5, 7	2	0.86	Y	Y	8	80	0.73	N	N
C17	1,1	BASIC	4, 3, 1, 2, 7, 5, 6	4, 1, 3, 2, 5 = 7, 6	4.5	0.68	N	N	8	108.5	0.98	Y	Y
C18	0,1	JSE (M = 1)	4, 3, 2, 7, 1, 6, 5	4, 3, 1, 7, 2, 6, 5	0	1	Y	Y	8	104	0.93	Y	N
C19	0,1	NWT = 3(EXP WI)	3, 6, 1, 2, 4, 7, 5	3, 6, 1, 2, 4, 5, 7	0	1	Y	Y	8	110	0.98	Y	Y
C20	0,1	NWT = 4(EXP(WI-WJ))	3, 6, 4, 7, 5, 1, 2	3, 6, 2 = 4, 5 = 7	2	0.86	Y	Y	8	84	0.76	N	N
C21	1,0	BASIC	4, 3, 1, 2, 7, 5, 6	4, 1, 3, 2, 5 = 7, 6	4.5	0.68	N	N	8	108.5	0.98	Y	Y
C22	0,0	JSE (M = 2) NWT = 3	3, 6, 4, 1, 2, 5, 7	3, 6, 1 = 2 = 4, 7, 5	1	0.93	Y	Y	8	104	0.96	Y	N
C23	0,1	JSE (M = 2) NWT = 3	3, 6, 4, 1, 2, 5, 7	3, 6, 1 = 2 = 4, 7, 5	1	0.93	Y	Y	8	104	0.96	Y	N
C24	0,0	JSE (M = 2) NWT = 4	3, 6, 4, 5, 7, 1, 2	3, 6, 4, 5, 1, 2 = 7	0	1	Y	Y	8	107.5	0.97	Y	Y

TABLE 3. VERIFICATION DEMONSTRATION RESULTS PARTIAL SUBLISTS

Run No.	Score Const	Syn Compl	Parameter Varied	Adj Borda Rank Order	Preference Rank Order	Consistency D	Consistency Zeta	Consistency 5%	Consistency 1%	Results Concordance M	Results Concordance S	Results Concordance W	Results Concordance 5%	Results Concordance 1%
P 1	0,0		Partial Basic	1 > 2 > 4 > 3 > 7 > 5 > 6	1 = 2 > 3 = 4 > 5 = 7 > 6	4	0.71	Y	N	8	107.5	0.99	Y	Y
P 2	0,0		NWT = 1(WI)	3, 1, 2, 4, 6, 7, 5	1 = 2 = 3, 6, 4, 5, 7	1.5	0.89	Y	Y	8	102	0.94	Y	N
P 3	0,0		NWT = 2(WI·WJ)	1, 3, 2, 6, 4, 7, 5	1, 2, 3 = 6, 4 = 5 = 7	1	0.93	Y	Y	8	101.5	0.95	Y	N
P 4	0,0		NWT = 3(EXP WI)	3, 6, 1, 2, 4, 7, 5	3, 1 = 2, 6, 4, 5, 7	0.5	0.96	Y	Y	8	102.5	0.92	Y	N
P 5	0,0		NWT = 4(EXP(WI·WJ))	6, 3, 1, 2, 4, 7, 5	1, 6, 2, 3, 4 = 5 = 7	1	0.93	Y	Y	8	96	0.89	N	N
P 6	0,0		NWT = 5(WI EXP WJ)	1, 5, 2, 3, 4, 6, 7	1, 2, 3 = 6, 5 = 7, 4	6	0.57	N	N	8	84	0.76	N	N
P 7	0,0		NWT = 6(WJ EXP WI)	3, 6, 1, 2, 4, 7, 5	3, 1, 2, 6, 4 = 5 = 7	2	0.86	Y	Y	8	100	0.93	Y	N
P 8	0,0		NWT = 7(+WI+WJ)	1, 2, 3, 4, 7, 6, 5	1, 2, 3, 4 = 5 = 7, 6	1	0.93	Y	Y	8	102	0.94	Y	N
P 9	0,0		NWT = 8(Log(WI·WJ))	1, 2, 3, 4, 7, 6, 5	1, 2, 3, 4 = 7, 5 = 6	2	0.86	Y	Y	8	109	0.99	Y	Y
P10	0,0	Y	JCONV 3	1, 2, 4 = 7, 3, 5, 6	1, 2, 7, 4, 5, 3 = 6	5.5	0.61	N	N	8	106	0.96	Y	Y
P11	0,0	Y	JCONV 4	1 = 3, 2, 4, 7, 5, 6	2 = 3, 1, 4, 5, 7, 6	1.5	0.89	Y	Y	8	103.5	0.94	Y	N
P12	0,0		JSE (M = 1)	2, 4, 1, 3, 7, 6, 5	2, 4, 1 = 3, 7, 6, 5	0	1	Y	Y	8	110.5	1.0	Y	Y
P13	0,0		JSE (M = 2)	4, 2, 1, 3, 7, 6, 5	2 = 4, 3, 1, 7, 6, 5	2	0.86	Y	Y	8	108.5	0.98	Y	Y
P14	1,1		NWT = 3(EXP WI)	3, 6, 1, 2, 4, 7, 5	3, 1 = 2, 6, 4, 5, 7	0.5	0.96	Y	Y	8	102.5	0.92	Y	N
P15	1,1		NWT = 4(EXP(WI·WJ))	6, 3, 1, 2, 7, 4, 5	1, 2, 6, 3, 4 = 5 = 7	1	0.93	Y	Y	8	90	0.83	N	N
P16	1,1		BASIC	1, 2, 4, 3, 7, 5, 6	1, 2, 3, 4, 5, 7, 6	4	0.71	Y	N	8	107.5	0.99	Y	Y
P17	1,1	Y	JCONV 3	1, 2, 4 = 7, 3, 5, 6	1, 2, 7, 4, 5, 3 = 6	5.5	0.61	N	N	8	106	0.96	Y	Y
P18	0,1		BASIC	1, 2, 4, 3, 7, 5, 6	1 = 2, 3 = 4, 5 = 7, 6	4	0.71	Y	N	8	107.5	0.99	Y	Y
P19	0,1	Y	JCONV 3	1, 2, 4 = 7, 3, 5, 6	1, 2, 7, 4, 5, 3 = 6	5.5	0.61	N	N	8	106	0.96	Y	Y
P20	0,1		NWT = 3	3, 6, 1, 2, 4, 7, 5	3, 1 = 2, 6, 4, 5, 7	0.5	0.96	Y	Y	8	102.5	0.92	Y	N
P21	1,0		BASIC	1, 2, 4, 3, 7, 5, 6	1 = 2, 3 = 4, 5 = 7, 6	4	0.71	Y	N	8	107.5	0.99	Y	Y
P22	0,0	Y	JCONV 3, JSE (M = 2), NWT = 3	3, 6, 2, 4, 1, 5, 7	2 = 3, 1, 4 = 6, 7, 5	3	0.79	Y	N	8	95	0.86	N	N

TABLE 3. (CONCLUDED)

Run No.	Score Const	Syn Compl	Parameter Varied	Adj Borda Rank Order	Preference Rank Order	Consistency				Results Concordance				
						D	Zeta	5%	1%	M	S	W	5%	1%
P23	0,1	Y	JCONV 3, JSE (M = 2), NWT = 3	3 > 6 > 2 > 4 > 1 > 5 > 7	2 = 3 > 1 > 4 = 6 > 7 > 5	3	0.79	Y	N	8	95	0.86	N	N
P24	0,0	Y	JCONV 4, JSE (M = 2), NWT = 4	6, 3, 1, 2, 7, 4, 5	1 = 3, 2 = 6, 7, 4, 5	2	0.86	Y	Y	8	101	0.92	Y	N
P25	0,1	Y	JCONV 4, JSE (M = 2) NWT = 4	6, 3, 1. 2, 7, 4, 5	1 = 3, 2 = 6, 7, 4, 5	2	0.86	Y	Y	8	101	0.92	Y	N

employed. The validation was divided into areas of method emphasis in the literature examples as follows: Borda and adjusted Borda; Borda, Condorcet, and Black; Borda, Condorcet, Black and Copeland; Copleland; Shannon preference and others; and special purpose examples to validate other model areas such as tied data and evaluation tests. Each case in Tables 4 through 9 presents the literature example, its published results, the comparable results from the computer model, and additional model results.

All six tables have the same format. The left half of each table page is quoted from the literature. First the reference identification is listed, then the example sublist rank orders are shown. Last, key answers from the literature are given. The right half of each table page contains results from aggregating the literature example sublists in the computer model. The upper left portion of the computer model side of the page contains the various final rank orders as computed. The upper right portion of the model side of the page contains the results of the coefficient of consistency testing of the preference matrix. The lower portion of the model side of the page contains coefficient of concordance results for the sublists and for selecte. pairs of final aggregation results.

For Case 1 of Table 4, Richelson presented X as the Borda winner which is in agreement with both computed Borda orders. "Majority" in Case 6 means the alternative which has the most "majority" victories. In the model, "majority" would correspond to the PREF order or the Copeland order if different matrix scoring constants are considered. Again, in Cases 3, 4, and 6, the computer results correspond to the literature example. In Cases 2, 5, and 7 through 11, the literature examples give the Borda and in some cases, the adjusted Borda counts. For Cases 2, 5, 7, and 11, where there are no ties in the sublist ranks, the computer data fully agrees with the literature examples. But in Cases 8, 9, and 10, where there are ties (indifference) in the sublist ranks, the computed adjusted Borda rank order counts agree with the literature, but the Borda counts do not match. Black (BK-B1) said that the purpose of the alternate Borda count method was to correct problems in the Borda count method when ties exist. Black's Borda method assigns to a tied alternative the score of the average tied position while the Borda count

TABLE 4. MODEL VALIDATION WITH LITERATURE - I

Borda and Adjusted Borda

Literature	
Case 1 Ref: Richelson (30) p. 42	
Qty	Sublist Orders
1	x > y > z
2	x > z > y
4	y > x > z
Answer:	Borda: X

Model Results		
Aggregation Orders		Consistency
Borda:	x > y > z	D = 0
Adj. Borda:	x > y > z	zeta = 1
Pref:	y > x > z	5% Cons: Yes
Fuzzy:	y > x > z	1% Cons: Yes

Concordance	Sublists	Borda/Pref
Mean:	14	4
Sum sq:	38	6
Coeff W:	0.388	0.75
5% Conc:	No	No
1% Conc:	No	No

TABLE 4. (CONTINUED)

Borda and Adjusted Borda

Case 2 Ref: Black (2) p. 61

Qty	Sublist Orders
1	$A_3 > A_2 > A_1 > A_4 > A_5$
2	$A_1 > A_2 > A_3 > A_4 > A_5$
8	$A_4 > A_5 > A_3 > A_2 > A_1$
9	$A_5 > A_4 > A_3 > A_2 > A_1$
15	$A_2 > A_1 > A_3 > A_4 > A_5$

Answer: Borda Count:
$A_1 = 55$, $A_2 = 86$, $A_3 = 72$,
$A_4 = 77$, $A_5 = 60$

Aggregation Orders		Consistency
Borda Count:	$A_1 = 55$, $A_2 = 86$, $A_3 = 72$, $A_4 = 77$, $A_5 = 60$	D = 0
Borda = Adj Borda:	$A_2 > A_4 > A_3 > A_5 > A_1$	zeta = 1
Pref:	$A_3 > A_2 > A_1$	5% Cons: Yes
	$> A_4 > A_5$	1% Cons: Yes

Concordance

	*Sublists	Borda/ Pref
Mean:	15	6
Sum Sq:	18	26
Coeff W:	0.072	0.65
5% Conc:	No	No
1% Conc:	No	No

*See the text.

TABLE 4. (CONTINUED)

Borda and Adjusted Borda

Case 3 Ref: Moon (23) p. 241

Qty	Sublist Orders
1	$C_2 > C_3 > C_4 > C_1$
1	$C_3 > C_4 > C_1 > C_2$
1	$C_4 > C_1 > C_2 > C_3$
2	$C_1 > C_2 > C_3 > C_3$

Answer: Borda: $C_1 > C_2 > C_3 > C_4$

Aggregation Orders		Consistency
Borda:	$C_1 > C_2 > C_3 > C_4$	D = 2
Adj Borda:	$C_1 > C_2 > C_3 > C_4$	zeta = 0
Pref:	$C_1 = C_2 > C_3 = C_4$	5% Cons: No
Fuzzy:	$C_1 > C_2 = C_3 = C_4$	1% Cons: No

Concordance

	Sublists	Borda/ Pref	Borda/ Fuzzy	Pref/ Fuzzy
Mean:	12.5	5	5	5
Sum Sq:	5	17	14	11
Coeff W:	0.040	0.944	0.875	0.786
5% Conc:	No	No	No	No
1% Conc:	No	No	No	No

TABLE 4. (CONTINUED)

Borda and Adjusted Borda

Case 4 Ref: Richelson (28) p. 33

Qty	Sublist Orders
1	X > Y > B > A
1	B > X > Y > A

Answers: Borda = Copeland = Dodgson = Black = X

Aggregation Orders		Consistency
Borda:	X > B > Y > A	D = 0.5
Adj Borda:	X > B > Y > A	zeta = 0.75
Pref:	X > B > Y > A	5% Cons: No
Copeland:	X > B > Y > A	
Fuzzy:	X = B > Y = A	1% Cons: No

Concordance

	Sublists	Borda/ Pref	Borda/ Fuzzy	Pref/ Fuzzy
Mean:	5	5	5	5
Sum Sq:	14	20	17	17
Coeff W:	0.70	1.0	0.944	0.944
5% Conc:	No	Yes	No	No
1% Conc:	No	Yes	No	No

TABLE 4. (CONTINUED)

Case 5 Ref: Richelson (31) p. 173	
Qty	**Sublist Orders**
5	$A_3 > A_1 > A_4 > A_2$
7	$A_1 > A_3 > A_2 > A_4$
9	$A_2 > A_1 > A_4 > A_3$
Answer:	Borda Count: $A_1 = 49$, $A_2 = 34$, $A_3 = 29$, $A_4 = 14$

Aggregation Orders		Consistency
Borda Count:	$A_1 = 49$, [illegible]	
	$A_3 =$ [illegible]	D = 0
Borda:	$A_1 >$ [illegible] $A_3 > A_4$	Beta = 1.0
Adj Borda:	A_1 [illegible] $> A_3 > A_4$	5% Cons: Yes
Pref:	A_1 [illegible] $> A_3 > A_4$	1% Cons: Yes

Concordance	Sublists	Borda Pref
Mean:	[illegible].5	5
Sum Sq:	[illegible]	13
Coeff W:	[illegible]	0.90
5% Conc:	No	No
1% Conc:	No	No

TABLE 4. (CONTINUED)

Case 6 Ref: Fishburn (19) p. 80	
Qty	**Sublist Orders**
1	C > A > B
1	B > A > C
2	B > C > A
3	A > B > C

Answer: Borda: B
Adj Borda: B
"Majority": A

Aggregation Orders		Consistency
Borda:	B > A > C	D = 0
Adj Borda:	B > A > C	beta = 1.0
Pref:	A > B > C	SE Cons: Yes
Fuzzy:	A > B > C	IE Cons: Yes

Concordance		
	Sublists	Borda/Pref
Mean:	14	4
Sum Sq:	14	6
Coeff W:	0.143	0.75
SE Conc.	No	No
IE Conc:	No	No

TABLE 4. (CONTINUED)

Case 7 Ref: Black (2) p. 63

Qty	Sublist Orders
2	$A_3 > A_2 > A_1 > A_4$
5	$A_2 > A_1 > A_3 > A_4$
11	$A_1 > A_2 > A_3 > A_4$
15	$A_4 > A_3 > A_2 > A_1$

Answer: Borda Count:
$A_1 = 45$, $A_2 =$ 5[illegible],

$A_3 = 52$, $A_4 = 45$

Adj Borda Count:
$A_1 = -9$, $A_2 = 13$,

$A_3 = 5$, $A_4 = -9$

Aggregation Orders		Consistency
Borda Count:	$A_1 = 45$, $A_2 = 56$, $A_3 = 52$, $A_4 = 45$	D = 0
Adj Borda Count:	$A_1 = -9$, $A_2 = 13$, $A_3 = 5$, $A_4 = -9$	zeta = 1.0
Borda = Adj Borda:	$A_2 > A_3 > A_1 = A_4$	5% Cons: Yes
Pref:	$A_{[illegible]} > A_2 > A_1 > A_4$	1% Cons: Yes

Concordance

	*Sublists	Borda/Pref
Mean:	10	5
Sum Sq:	14	16.5
Coeff. W:	0.175	0.868
5% Conc:	No	No
1% Conc:	No	No

TABLE 4. (CONTINUED)

Case 8 Ref: Black (2) p. 63	
Qty	**Sublist Orders**
5	$A_2 > A_0 > A_1$
6	$A_1 = A_0 > A_2$
9	$A_0 > A_1 = A_2$
20	$A_1 > A_0 > A_2$

Answers: Borda Count:
$A_1 = 46,\ A_2 = 10,\ A_0 = 49$

Adj Borda Count:
$A_1 = 27,\ A_2 = -51,\ A_0 = 24$

Aggregation Orders		Consistency
Borda Count:	A_1 = 53.5,	D = 0
	A_2 = 14.5	
	A_0 = 52	
Adj Borda Count:	A_1 = 27,	zeta = 1
	A_2 = -51,	
	A_0 = 24	
Borda = Adj Borda:	$A_1 > A_0 > A_3$	5% Cons: Yes
Pref:	$A_1 > A_0 > A_3$	1% Cons: Yes

Concordance	*Sublists	Borda/Pref
Mean:	8	4
Sum Sq:	4.5	8
Coeff. W:	0.161	1.0
5% Conc:	No	Yes
1% Conc:	No	Yes

TABLE 4. (CONTINUED)

Case 9 Ref: Black (2) p. 64	
Qty	**Sublist Orders**
4	$A_3 > A_2 > A_1$
6	$A_3 > A_1 = A_2$
9	$A_1 > A_2 > A_3$

Answers: Borda Count:
$A_1 = 18$, $A_2 = 13$, $A_3 = 20$

Adj Borda Count:
$A_1 = 4$, $A_2 = -6$, $A_3 = 2$

Aggregation Orders		Consistency
Borda Count:	$A_1 = 21$,	D = 0
	$A_2 = 16$,	
	$A_3 = 20$	
Adj Borda Count:	$A_1 = 4$,	zeta = 1.0
	$A_2 = -5$,	
	$A_3 = 2$	
Borda = Adj Borda:	$A_1 > A_3 > A_2$	5% Cons: Yes
Pref:	$A_3 > A_1 > A_2$	1% Cons: Yes

Concordance	*Sublists	Borda/Pref
Mean:	6	4
Sum Sq:	1.5	6
Coeff W:	0.088	0.75
5% Conc:	No	No
1% Conc:	No	No

TABLE 4. (CONTINUED)

Case 10 Ref: Black (2) p. 65	
Qty	Sublist Orders
12	$A_3 > A_2 = A_4 > A_1$
25	$A_1 > A_3 = A_4 > A_2$
45	$A_4 > A_2 > A_3 > A_4$
60	$A_1 = A_2 > A_3 > A_4$

Answers: Borda Count:
$A_1 = 195$, $A_2 = 177$,

$A_3 = 166$, $A_4 = 172$

Adj Borda Count:
$A_1 = 24$, $A_2 = 45$,

$A_3 = -24$, $A_4 = -45$

Aggregation Orders		Consistency
Borda Count:	$A_1 = 225$,	D = 2
	$A_2 = 233$	
	$A_3 = 201$,	
	$A_4 = 190.5$	
Adj Borda Count:	$A_1 = 24$, $A_2 = 45$,	zeta = 0
	$A_3 = -24$, $A_4 = -45$	
Borda = Adj Borda:	$A_2 > A_1 > A_3 > A_4$	5% Cons: No
Pref:	$A_1 = A_2 > A_3 = A_4$	1% Cons: No

Concordance

	*Sublists	Borda/Pref
Mean:	5	5
Sum Sq:	20	17
Coeff W:	1.0	0.944
5% Conc:	Yes	No
1% Conc:	Yes	No

TABLE 4. (CONTINUED)

Case 11 Ref: Black (2) p. 158	
Qty	**Sublist Orders**
1	A > B > C
6	C > B > A
7	A > C > B
7	B > C > A

Answers: Borda Count:
A = 16, B = 21, C = 26

Aggregation Orders		Consistency
Borda Count:	A = 16,	D = 0
	B = 21,	
	C = 26	
Borda = Adj Borda:	C > B > A	zeta = 1
Pref:	C > B > A	5% Cons: Yes
		1% Cons: Yes

Concordance

	*Sublists	Borda/Pref
Mean:	8	4
Sum Sq:	0	8
Coeff W:	0	1.0
5% Conc:	No	Yes
1% Conc:	No	Yes

TABLE 4. (CONTINUED)

Case 12 Ref· Pattanáik (27) p. 170	
Qty	Sublist Orders
1	A > D > B > C
1	C > D > A > B
1	B > D > C > A
Answer:	Choice: D

Aggregation Orders	Consistency
Borda: D > A = B = C	D = 1
Pref: D > A = B = C	zeta = 0.5
Fuzzy: D > A = B = C	5% Cons: No
	1% Cons: No

Concordance	Sublists
Mean:	7.5
Sum Sq:	3
Coeff W:	0.067
5% Conc:	No
1% Conc:	No

TABLE 4. (CONTINUED)

Case 13 Ref: Pattanaik (27) p. 159		Aggregation Orders	Consistency
Qty	Sublist Orders		
1	A = C > B = D	Borda: A = B = C = D	D = 2
1	B > A > D > C	Pref: A = B = C = D	zeta = 0
1	D > C > B > A	Fuzzy: A = B = C = D	5% Cons: No
			1% Cons: No
Answer:	ϕ		

Concordance	Sublists
Mean:	7.5
Sum Sq:	0
Coeff W:	0
5% Conc:	No
1% Conc:	No

TABLE 4. (CONTINUED)

Case 14 Ref: Black (15) p. 14	
Qty	Sublist Orders
3	B > C > A
3	C > A > B
4	A > C > B
Answer:	Adj Borda Count: A = 2, B = -8, C = 6

Aggregation Orders		Consistency
Adj Borda Count:	A = 2, B = -8 C = 6	D = 0
Borda = Adj Borda:	C > A > B	zeta = 1
Pref:	C > A > B	5% Cons: Yes
Fuzzy:	C > A > B	1% Cons: Yes

Concordance	
	Sublists
Mean:	2.0
Sum Sq:	26
Coeff W:	0.13
5% Conc:	No
1% Conc:	No

TABLE 4. (CONTINUED)

Case 15 Ref: Black (15) p. 14	
Qty	**Sublist Orders**
3	B > C > A
3	C > B > A
4	A > C > B
Answer:	Adj Borda Count: A = -4, B = -2, C = 6

Aggregation Orders		Consistency
Adj Borda Count:	A = -4, B = -2, C = 6	D = 0
Borda = Adj Borda:	C > B > A	zeta = 1
Pref:	C > B > A	5% Cons: Yes
Fuzzy:	C > A > B	

Concordance	
	Sublists
Mean:	20
Sum Sq:	14
Coeff W:	0.07
5% Conc:	No
1% Conc:	No

TABLE 4. (CONCLUDED)

Case 16 Ref: Richelson (30) p. 42	
Qty	Sublist Orders
2	x > z > y
2	x > y > z
3	y > z > x
Answer:	Borda: x = y

Aggregation Orders		Consistency
Borda = Adj Borda:	x = y > z	D = 0
Pref:	x > y > z	zeta = 1
Fuzzy:	x > y > z	5% Cons: Yes
		1% Cons: Yes

Concordance		
	Sublists	Borda/Pref
Mean:	14	4
Sum Sq:	6	6.5
Coeff W:	0.061	0.929
5% Conc:	No	No
1% Conc:	No	No

TABLE 5. MODEL VALIDATION WITH LITERATURE II

Borda, Condorcet, and Black	
Case 1 Ref: Fishburn (17) p. 540	
Qty	Sublist Orders
1	x > y > A > B > C
1	y > A > C > B > x
1	C x > y > A > B
1	x > y > B > C > A
1	y > B > A > x > C
Answers:	Borda: y
	Cordorcet: x

Aggregation Orders		Consistency
Borda:	y > x > A > B = C	D = 0
Condorcet:	x	zeta = 1
Pref:	x > y > A > B > C	5% Cons: Yes
Fuzzy:	x > y > C > A > B	1% Cons: Yes

Concordance	
	Sublists
Mean:	15
Sum Sq:	62
Coeff W:	0.248
5% Conc:	No
1% Conc:	No

TABLE 5. (CONTINUED)

Borda, Condorcet, and Black			
Case 2 Ref: Richelson (31) p. 173		Aggregation Orders	Consistency
Qty	Sublist Orders	Borda = Black: A > x = y = z > B = C = D	b = 2
1	x > y > z > A > B > C > D	Condorcet: ϕ	
1	y > z > x > A > C > D > B	Pref: x = y = z > A > B = C = D	zeta = 0.857
1	A > D > B > C > Z > x > y	Fuzzy: x = y = z > A > B = C = D	5% Cons: Yes
Answers:	Borda = Black: A Condorcet: ϕ Borda Scores: x = y = z = 11, A = 12, B = C = D = 6	Borda Scores: x = y = z = 11, A = 12, B = C = D = 6	1% Cons: Yes

Concordance		
	Sublists	Borda/Pref
Mean.	[illegible]	[illegible]
Sum Sq:	48	84
Coeff W:	0.190	0.875
5% Conc:	No	No
1% Conc:	No	NO

[illegible] (CONTINUED)

Borda, Condorcet and Black

Case 3 Ref: Fishburn (17) p. 540	
Qty	**Sublist Orders**
1	A > C > B
2	B > A > C
Answer:	Borda: A = B
	Condorcet: B

Aggregation Orders		Consistency
Borda:	A = B > C	D = 0
Condorcet:	B	zeta = 1
Pref:	B > A > C	5% Cons: Yes
Fuzzy:	B > A > C	1% Cons: Yes

Concordance	Sublists	Borda/Pref
Mean:	6	4
[illegible]	5	6.5
Coeff W.	[illegible] 3	0.929
5% Conc:	[illegible]	
1% Conc:	No	No

TABLE 5. (CONTINUED)

Borda, Condorcet, and Black				
Case 4 Ref: Colman ([illegible] p. 15		Aggregation Orders		[illegible]
Qty	Sublist Orders	Borda:	B [illegible]	[illegible]
2	C > B > A	Condorcet: [illegible]		[illegible]
3	B > C > A	[illegible]	B > C > A	5% of Cons: Yes
4	A > B > C	Fuzzy:	B > A > C	1% Cons: Yes
Answers: Plurality [illegible]				

Concordance	
	Sublists
Mean:	18
Sum Sq:	14
Coeff W:	0.056
5% Conc:	No
1% Conc:	No

TABLE 5 (CONTINUED)

Borda, Condorcet, and Black

Case 5 Ref: Richelson (31) p. 174

Qty	Sublist Orders
1	$y > \quad > A_1 > A_2 > A_3 > A_4$
1	$y > x > A_3 \quad A_4 > A_2 > A_1$
1	$A_1 > A_2 > A_3 > Y > X > A_4$
1	$X > A_2 > A_1 > A_3 > A_4 > Y$

Answers:	Borda = Black: x
	Condorcet: ϕ (strong)
	Borda Scores: $x = 14$, $y = 12$, $A_1 = A_2 = 11$, $A_3 = 9$, $A_4 = 3$

Aggregation Orders		Consistency
Borda = Black:	$x > y > A_1 = A_2 > A_3 \quad A_4$	D = 3
Condorcet:	ϕ (strong)	
Pref:	$x > y > A_1 = A_2 > A_3 > A_4$	zeta = 0.625
Fuzzy:	$y > A_1 = A_2 = A_3 = x > A_4$	5% Cons: No
Borda Scores:	$x = 14$, $y = 12$, $A_1 = A_2 = 11$, $A_3 = 9$, $A_4 = 3$	1% Cons: No

Concordance

	Sublists
Mean	14
Sum Sq:	72
Coeff W:	0.257
5% Conc:	No
1% Conc:	No

TABLE 5. (CONTINUED)

Case 6 Ref: Richelson (31) p. 174	
Qty	Sublist Orders
1	$y > x > A_3 > A_4 > A_2 > A_1$
1	$A_1 > A_2 > A_3 > y > x > A_4$
1	$x > A_2 > A_1 > A_3 > A_4 > y$
1	$y > x > A_1 > A_2 > A_3 > A_4$
1	$x > y > A_1 > A_2 > A_3 > A_4$
Answers:	Condorcet: y (strong)

Aggregation Orders		Consistency
Borda:	$x > y > A_1 > A_2 > A_3 > A_4$	D = 0
Condorcet:	y (strong)	zeta = 1
Pref:	$y > x > A_1 > A_2 > A_3 > A_4$	5% Cons: Yes
Fuzzy:	$y > x > A_1 = A_2 = A_3 > A_4$	1% Cons: Yes

Concordance	Sublists
Mean	17.5
Sum Sq:	153.5
Coeff W:	0.351
5% Conc:	No
1% Conc:	No

TABLE 5. (CONTINUED)

Case 7 Ref: Fishburn (17) p. 540	
Qty	Sublist Orders
1	A > C > B
2	B > A > C
Answers:	Borda: A = B
	Condorcet: B

Aggregation Orders		Consistency
Borda:	A = B > C	D = 0
Pref:	B > A > C	zeta = 1
Condorcet:	B	5% Cons: Yes
Fuzzy:	B > A > C	1% Cons: Yes

Concordance		
	Sublists	Borda/Pref
Mean:	6	4
Sum Sq:	6	6,5
Coeff W:	0.33	0.929
5% Conc:	No	No
1% Conc:	No	No

TABLE 5. (CONTINUED)

Case 8 Ref: Black (15) p. 14	
Qty	Sublist Orders
3	B > A > C
3	C > A > B
4	A > B > C
Answers:	Adj Borda Count: A = 8, B = 0, C = -8
	Condorcet: A

Aggregation Orders		Consistency
Adj Borda Count:	A = 8, B = 0, C = -8	D = 0
Borda = Adj Borda:	A > B > C	zeta = 1
Pref:	A > B > C	5% Cons: Yes
Condorcet:	A	
Fuzzy:	A > B = C	1% Cons: Yes

Concordance	Sublists
Mean:	20
Sum Sq:	32
Coeff W:	0.16
5% Conc:	No
1% Conc:	No

TABLE 5. (CONTINUED)

Case 9 Ref: Richelson (28) p. 335	
Qty **	Sublist Orders
49	C > B > A > x
50	x > B > A > C
Answer:	Black: x
	Borda: B
	Condorcet: x

Aggregation Orders		Consistency
Borda = Adj Borda:	B > x > C > A	D = 0
Condorcet:	x	zeta = 1
Black:	x	
Pref:	x > B > A > C	5% Cons: Yes
Fuzzy:	x > B = C > A	1% Cons: Yes

Concordance	
	Sublists
Mean:	242.5
Sum Sq:	4745
Coeff W:	0.101
5% Conc:	Yes
1% Conc:	Yes

** Literature Problem Quantities of 50 and 51 respectively were reduced one each, without loss of generalization, to permit model computation.

TABLE 5. (CONCLUDED)

Case 10 Ref: Richelson (28) p. 335	
Qty	**Sublist Orders**
1	B > x > C > A
1	B > A > C > x
1	C > x > B > A
1	x > B > A > C
2	A > C > x > B
Answers:	Borda = Black; A = B = C = x

Aggregation Orders		Consistency
Borda = Adj Borda:	A = B = C = X	D = 2
Pref:	A = B = C = X	zeta = 0
Fuzzy:	A = B = C = X	5% Cons: No
Condorcet:	¢	1% Cons: No
Black : Borda		

Concordance	Sublists
Mean:	15
Sum Sq:	0
Coeff W:	0
5% Conc:	No
1% Conc:	No

TABLE 6. MODEL VALIDATION WITH LITERATURE III

Borda, Condorcet, Black, and Copeland

Case 1 Ref: Fishburn (17) p. 54

Qty	Sublist Orders
1	y > z > W > T > x
1	T > W > z > y > x
2	y > x > z > W > T
2	x > T > W > z > y

Answers: Borda = Adj Borda: x

Condorcet: y

Copeland: x

Aggregation Orders		Consistency
Borda = Adj Borda:	x > T = y > z > W	D = 3.5
Condorcet:	y	zeta = 0.3
Pref:	x > y > T > z > W	5% Cons: No
Fuzzy:	y > x = T = z > W	1% Cons: No
Copeland:	x > y > T > z > W	

Concordance

	Sublists	Borda/ Pref	Borda/ Fuzzy
Mean:	18	6.1	6.0
Sum Sq:	16	38.5	27.5
Coeff W:	0.044	0.987	0.786
5% Conc:	No	Yes	No
1% Conc:	No	No	No

TABLE 6. (CONTINUED)

Borda, Condorcet, Black, and Copeland

Case 2 Ref: Richelson (28) p. 336

Qty	Sublist Orders
1	x > y > A > B > C
1	y > A > C > B > x
1	x > y > B > C > A
1	C > x > y > A > B
1	y > B > A > x > c

Answers: Black = Copeland: x

Copeland Scores:
A = 0, B = -2, C = -4, x = 4,
y = 2

Aggregation Orders	Consistency
Borda: y > x > A > B = C	T = 0
Black = Condorcet: x	zeta = 1
Pref: x > y > A > B > C	5% Cons: Yes
Fuzzy: x > y > C > A = B	1% Cons: Yes
Copeland: x > y > A > B > C	
Copeland Scores: A = 0, B = -2, c = -4, x = 4, y = 2	

Concordance

	Sublists	Borda/ Adj Borda	Borda:Pref
Mean:	15	6	6
Sum Sq:	62	38	36.5
Coeff W:	0.248	1.0	0.935
5% Conc:	No	Yes	No
1% Conc:	No	No	No

TABLE 6. (CONTINUED)

Borda, Condorcet, Black, and Copeland			
Case 3 Ref: Fishburn (17) p. 542		Aggregation Orders	Consistency
Qty	**Sublist Orders**	Borda = Black: x > A = y > B = C > D	D = 6
1	y > x > A > B > D > C	Condorcet: ∅	zeta = 0.25
1	C > D > y > B > A > x	Pref: x > A = y > B = C > D	5% Cons: No
1	x > A > B > C > D > y	Copeland: x > A = y > B = C > D	1% Cons: No
Answers:	Borda = Black = Copeland: x	Fuzzy: x = A = Y = B = C = D	
	Condorcet: ∅		

	Sublists	Borda/Pref
Mean:	10.5	7
Sum Sq:	5.5	66
Coeff W:	0.035	1.0
5% Conc:	No	Yes
1% Conc:	No	No

TABLE 6. (CONTINUED)

Borda, Condorcet, Black, and Copeland			
Case 4 Ref: Richelson (30) p. 43		Aggregation Orders	Consistency
Qty	Sublist Orders		
1	x > y > z > W	Borda: z > y > x > W	D = 2
1	y > z > W > x	Condorcet: ∅	zeta = 0
1	z > W > x > y	Pref: z = y > x = W	5% Cons: No
		Fuzzy: z = y = x > W	1% Cons: No
Answers:	Borda = Copeland: z = y	Copeland: z = y > x = W	

Concordance					
	Sublists	Borda/ Pref	Borda/ Fuzzy	Borda/ Copeland	Pref/ Fuzzy
Mean:	7.5	5	5	5	5
Sum Sq:	5	17	14	17	11
Coeff W:	0.111	0.944	0.875	0.944	0.786
5% Conc:	No	No	No	No	No
1% Conc:	No	No	No	No	No

TABLE 6. (CONTINUED)

Borda, Condorcet, Black, and Copeland

Case 5 Ref: Fishburn (18) p. 85

Qty	Sublist Orders
1	$A > D > x_1 > C > B > x_2 > x_3 > x_4 > x_5$
1	$B > x_5 > x_2 > A > x_4 > x_3 > C > D > x_1$
1	$C > D > x_2 > B > x_1 > A > x_4 > x_5 > x_3$

Answers: Borda = Black: B

Copeland: C

Scores:

	A	B	C	D	x_1	x_2	x_3	x_4	x_5
Borda	16	17	15	15	10	15	5	7	8
Copeland	4	4	6	4	-2	2	-8	-4	-6

Aggregation Orders	Consistency
Borda = Black: $B > A > C = D = x_2 > x_1 > x_5 > x_4 > x_3$	D = 4
Pref: $C > B = A = D = x_2 > x_1 > x_4 > x_5 > x_3$	zeta = 0.08667
Copeland: $C > B = A = D > x_2 > x_1 > x_4 > x_5 > x_3$	5% Cons: Yes
(All scores are the same)	1% Cons: Yes

Concordance

	Sublists	Borda/ Adj Borda	Borda/ Pref
Mean:	15	10	10
Sum Sq:	162	232	214
Coeff W:	0.515	1.0	0.922
5% Conc:	No	Yes	No
1% Conc:	No	No	No

TABLE 6. (CONTINUED)

Borda, Cond[illegible] Black, and Copeland

Case 6 Ref: Fishburn (17) p. 541

Qty	Sublist Orders
2	x > A > B > C > y
3	B > C > y > A > x
4	y > x > A > C > B

Answers:
Adj Borda: y
Condorcet: [illegible]
Black: y
Copeland: [illegible]
Copeland [illegible]
x:2, [illegible] = B:0, c:-2

Aggregation Orders	Consistency
[illegible] Scores: x:2, y = A = B:0, c:-2	D = 4
	zeta = 0.2
Borda = Adj Borda: y > x > A > B > C	5% Cons: No
Condorcet: [illegible]	1% Cons: No
Black = Borda	
Pref: x > A = B = Y > C	
Fuzzy: y > B = C > A = x	
Copeland: x > A = B = y > C	

Concordance

	Sublists	Borda/Pref
Mean:	27	6
Sum Sq:	34	30
Coeff W:	0.042	0.8'3
5% Conc:	No	No
1% Conc:	No	No

TABLE 7. MODEL VALIDATION WITH LITERATURE -IV

Copeland				
Case 1 Ref: Richelson (28) p. 335		Aggregation Orders		Consistency
Qty	Sublist Orders			
1	z > y > x > A	Borda:	x = y > z > A	D = 0
1	A > y > x > z	Pref:	x = y > z > A	zeta = 1
2	x > y > z > A	Fuzzy:	x = y > z = A	5% Cons: Yes
		Copeland:	x = y > z > A	1% Cons: Yes
Answer:	Copeland: x = y			

Concordance	
	Sublists
Mean.	10
Sum Sq:	18
Coeff W:	0.225
5% Conc:	No
1% Conc:	No

TABLE 7. (CONTINUED)

Copeland

Case 2 Ref: Richelson (28) p. 335	
Qty	**Sublist Orders**
1	x > y > A > B
1	A > x > y > B
1	y > A > x > B

Answers: Copeland: A = x = y > B

Aggregation Orders	Consistency
Borda = Adj Borda: A = x = y > B	D = 1
Pref: A = x = y > B	zeta = 0.5
Fuzzy: A = x = y > B	5% Cons: No
Copeland: A = x = y > B	1% Cons: No

Concordance

	Sublists
Mean:	7.5
Sum Sq:	27
Coeff W:	0.60
5% Conc:	No
1% Conc:	No

TABLE 7. (CONTINUED)

Copeland			
Case 3 Ref: Richelson (31) p. 174		Aggregation Orders	Consistency
Qty	Sublist Orders		
2	$y > x > A_1 > A_2 > A_3$	Borda: $x > y > A_1 = A_2 = A_3$	D = 3.5
1	$A_3 > A_2 > A_1 > y > x$	Pref: $x > y > A_1 = A_2 = A_3$	zeta = 0.30
1	$x > A_3 > A_2 > A_1 > y$	Fuzzy: $y > x = A_1 = A_2 = A_3$	5% Cons: No
		Copeland: $x > y > A_1 = A_2 = A_3$	1% Cons: No
Answer:	Copeland: x		

Concordance	
	Sublists
Mean:	12
Sum Sq:	8
Coeff W:	0.05
5% Conc:	No
1% Conc:	No

TABLE 7. (CONTINUED)

Copeland			
Case 4 Ref: Richelson (31) p. 174		Aggregation Orders	Consistency
Qty	Sublist Orders		
3	$y > x > A_1 > A_2 > A_3$	Borda: $x > y > A_1 > A_2 > A_3$	D = 0
1	$A_3 > A_2 > A_1 > y > x$	Pref: $y > x > A_1 > A_2 > A_3$	zeta = 1
1	$x > A_3 > A_2 > A_1 > y$	Fuzzy: $y > x > A_1 = A_2 = A_3$	5% Cons: Yes
Answer: Copeland: y		Copeland: $y > x > A_1 > A_2 > A_3$	1% Cons: Yes

Concordance

	Sublists	Borda/ Pref	Pref/ Fuzzy	Borda/ Copeland
Mean:	15	6	6	6
Sum Sq:	34	38	34	38
Coeff W:	0.136	0.95	0.944	0.95
5% Conc:	No	Yes	No	Yes
1% Conc:	No	No	No	No

TABLE 7. (CONTINUED)

Copeland				
Case 5 Ref: Richelson (31) p. 173	Aggregation Orders			Consistency
Qty Sublist Orders	Borda: y > x > z = W = T			D = 3.5
1 x > y > T > W > Z	Pref: y > x > z = W = T			zeta = 0.30
1 x > y > z > W > T	Fuzzy: x > y = z = W = T			5% Cons: No
1 y > w > z > T > X	Copeland: y > x > z = W = T			1% Cons: No
1 T > z > W > x > y				
Answer: Copeland: y	Concordance			
		Sublists	Borda/ Pref	Borda/ Copeland
	Mean:	12	6	6
	Sum Sq:	8	32	32
	Coeff W:	0.05	1.0	1.0
	5% Conc:	No	No	No
	1% Conc:	No	No	No

TABLE 7. (CONCLUDED)

Copeland

Case 6 Ref: Richelson (28) p. 335	
Qty	Sublist Orders
1	x > y > A > B
1	x > y > B > A
1	y > x > A > B
1	y > x > B > A

Answers: Copeland: x = y

Aggregation Orders	Consistency
Borda = Adj Borda: x = y > A = B	D = 0
Pref: x = y > A = B	zeta = 1
Fuzzy: x = y > A = B	5% Cons: Yes
Copeland: x = y > A = B	1% Cons: Yes

Concordance

	Sublists
Mean:	10
Sum Sq:	64
Coeff W:	0.80
5% Conc:	Yes
1% Conc:	Yes

TABLE 8. MODEL VALIDATION WITH LITERATURE -V

Shannon Preference and Others

Case 1 Ref: Shannon (32) p. xviii	
Qty	**Sublist Orders**
1	A > C > B > E > D
1	B > A > C > E > D
1	A > B > C > D > E

Answers: Borda: A > B > C > E > D

Pref: A > B > C > E > D

Coeff W = 0.84

5% Conc. Yes

Aggregation Orders		Consistency
Borda:	A > B > C > E > D	D = 0
Pref:	A > B > C > E > D	zeta = 1.0
Fuzzy:	A > B > C = D = E	5% Cons: Yes
		1% Cons: Yes

Concordance

	Sublists	Borda/ Pref	Pref/ Fuzzy
Mean:	9	6	6
Sum Sq:	76	40	34
Coeff W:	0.844	1.0	0.944
5% Conc:	Yes	Yes	No
1% Conc:	Yes	Yes	No

TABLE 8. (CONTINUED)

Shannon Preference and Others

Case 2 Ref: Shannon (32) p. xviii

Qty	Sublist Orders
1	A > C = E > B > D > G > F > I > H > J
1	B > C > A > D = E > H > F = J > G > I
1	B > A > C > D = E = F > H > I > G = J

Answers: Borda: A = B > C > E > D > F > H > G > I > J

Pref: B > A > C > E > D > F > H > G > I > J

Coeff W = 0.90

χ^2 cal = 24.30

5% Conc: Yes

	Aggregation Orders	Consistency
Adj Borda:	A = B > C > E > D > F > H > G > I > J	D = 0.50
Prefix:	B > A > C > E > D > F > H > G > I > J	zeta = 0.978
Fuzzy:	B > A = C > E = D = F = H = G = I = J	5% Cons: Yes 1% Cons: Yes

Concordance

	Sublists	Borda/ Pref	Pref/ Fuzzy
Mean:	16.5	11	11
Sum Sq:	629.5	328.5	244.5
Coeff W:	0.862	0.036	0.064
χ^2 =	23.3	17.9	15.1
5% Conc:	Yes	Yes	No
1% Conc:	Yes	No	No

TABLE 8. (CONTINUED)

Shannon Preference and Others

Case 3 Ref: Richelson (28) p. 33

Qty	Sublist Orders
1	A > x > D > B > C
1	D > x > A > B > C
1	C > x > B > A > D
2	B > x > A > D > C

Answer:	Condorcet: x
	Pref: x

Aggregation Orders	Consistency
Borda: x > B > A > D > C	D = 0
Pref: x > B > A > D > C	zeta = 1.0
Fuzzy: x > B > A = D = C	5% Cons: Yes
Copeland: x > B > A > D > C	1% Cons: Yes
Condorcet: x	

Concordance

	Sublists	Borda/ Pref	Pref/ Fuzzy
Mean:	15	6	6
Sum Sq:	70	40	34
Coeff W:	0.28	1.0	0.944
5% Conc:	No	Yes	No
1% Conc:	No	Yes	No

TABLE 2. (CONTINUED)

Shannon Preference and Others

Case 4. Ref: Klahr (22) p. 384	
Qty	**Sublist Orders**
1	A > B > C
1	B > A > C
1	A > C > B

Answers: Majority: A > B > C

Aggregation Orders	Consistency
Borda = Adj Borda: A > B > C	D = 0
Pref: A > B > C	zeta = 1
Fuzzy: A > B > C	5% Cons: Yes
	1% Cons: Yes

Concordance

	Sublists
Mean	6
Sum Sq:	8
Coeff W:	0.444
5% Conc:	No
1% Conc:	No

TABLE 8. (CONTINUED)

Shannon Preference and Others

Case 5 Ref: Klahr (22) p. 384

Qty	Sublist Orders
1	A > B > C
1	C > A > B
1	B > C > A

Answers: Majority: Intransitive

Aggregation Orders	Consistency
Borda = Adj Borda: A = B = C	D = 1
Pref: A = B = C	zeta = 0
Fuzzy: A = B = C	5% Cons: No
	1% Cons: No

Concordance

	Sublists
Mean:	6
Sum Sq:	0
Coeff W:	0
5% Conc:	No
1% Conc:	No

TABLE 8. (CONCLUDED)

Shannon Preference and Others			
Case 6 Ref: Black (14) p. 269		Aggregation Orders	Consistency
Qty	Sublist Orders	Borda = Adj Borda: $A_4 > A_3 = A_2 > A_1$	D = 0
1	$A_4 > A_2 > A_3 > A_1$	Pref: $A_4 > A_2 > A_3 > A_1$	zeta = 1
1	$A_4 > A_3 > A_1 > A_2$	Fuzzy: $A_4 > A_2 > A_3 > A_1$	5% Cons: Yes
1	$A_3 > A_1 > A_4 > A_2$		1% Cons: Yes
2	$A_2 > A_4 > A_3 > A_1$		

Answers: Least Dominated: $A_4 > A_2 > A_3 > A_1$

Concordance	Sublists	Borda/ Pref
Mean:	12.5	5
Sum Sq:	33	18.5
Coeff W:	0.264	0.974
5% Conc:	No	No
1% Conc:	No	No

TABLE 9. MODEL VALIDATION WITH LITERATURE -VI

Special

Case 1 (Ties) Ref: Kendal (7) p. 97

Qty	Sublist Orders
1	1 > 3 > 5 > 2 = 4 > 7 > 6 = 9 > 8 > 10
1	2 > 1 = 3 > 4 = 5 > 8 = 10 > 6 > 7 > 9
1	2 > 1 > 3 = 4 = 5 = 6 > 7 = 8 = 9 > 10

Answer: ΣT: 9.5
Sum Sq: 591
Coeff W: 0.828

Aggregation Orders	Consistency
Adj Borda: 1 > 2 > 3 > 5 > 4 > 6 > 7 > 8 > 9 > 10	D = 0.5 zeta = 0.9875 5% Cons: Yes 1% Cons: Yes
Pref: 2 > 1 > 3 > 5 > 4 > 6 > 7 > 8 > 9 > 10	
Fuzzy: 2 > 1 > 3 > 4 = 5 = 6 = 7 = 8 = 9 = 10	

Concordance

	Sublists	Borda/ Pref
Mean:	16.5	11
ΣT:	9.5	0
Sum Sq:	591	328
Coeff W:	0.825	0.994
5% Conc:	Yes	Yes
1% Conc:	Yes	No

TABLE 9. (CONTINUED)

Special	
Case 2 Ref: Kendall (7) p. 145	Aggregation Orders / Consistency

Preference Matrix

Sum		A	B	C	D	E	F
4	A	-	1	1	0	1	1
2	B	0	-	0	1	1	0
4	C	0	1	-	1	1	1
1	D	1	0	0	-	0	0
2	E	0	0	0	1	-	1
2	F	0	1	0	1	0	-

Answers: D = 5, zeta = 0.375

Aggregation Orders

Aggregation Orders	Consistency
Pref: A = C > B = E = F > D	D = 5.0
(Same Pref Matrix)	zeta = 0.375
	5% Cons: No
	1% Cons: No

Concordance (N/A)

TABLE 9. (CONCLUDED)

Special			
Case 3 Ref: Kendall (7) p. 94		**Aggregation Orders**	**Consistency**
Qty	**Sublist Orders**	Borda = Adj Borda: C > B > E > A > F > D	D = 2
1	C > F > E > B > A > D		zeta = 0.75
1	C > A > B > F > D > E	Pref: C > B = E > A > F > D	5% Cons: No
1	B > E > D > A > F > C		1% Cons: No
1	E > C > B > A > D > F		

Answers: Mean: 14

Sum Sq: 64

Coeff W: 0.229

Concordance	Sublists	Borda/Pref
Mean:	14	7
Sum Sq:	64	63.5
Coeff W:	0.229	0.953
5% Conc:	No	Yes
1% Conc:	No	Yes

derived from the Shannon frequency matrix, divides each vote between the tied alternative paris. Borda's memo appears to permit either interpretation (See Black (15)). The literature and model differences in the Borda methods cancel out when the column totals are subtracted from the row totals in the adjusted Borda method.

For Cases 2, 5 and 7 through 11, the asterisk (*) at the sublist concordance results denotes that the examples indicated contain repetitions of sublists such as nine sublists of A1 > A2 > A3 in Case 9. For these cases, the repetition of sublists was input as multiplicative decision-maker judge weights (WJ). The rank orders are the same but the sublist concordance data are based on single occurrences of each type of sublist (i.e., three sublists tested for Case 9). Since the computer model is limited to aggregate 100 or fewer sublists, Case 10, with 142 sublists could only be computed by the judge weights approach.

Case 13 presents an example which is intransitive and has no discrete solution. Note that the model handles intransitivity as indifference.

Finally, in Cases 14, 15, and 16, the computed results agree with the literature examples. It was concluded that the model adequately represents the Borda and adjusted Borda mojority rank methods.

For the cases of Table 5, for Porda, Condorcet, and Black method examples, the Borda results are computed, and the Condorcet results are observed by scanning the rows of the preference matrix for zeros. If a zero (other than on the main diagonal) exists, then the alternative does not have a majority over all other alternatives, which is the Condorcet criterion. The Black answer is the Condorcet winner if one exists. If a Condorcet winner does not exist, the Black winner is the Borda winner. A strong Condorcet winner is one that beats, not ties, all other alternatives. For Table 9, computed results for all ten cases agree with the literature examples. For Cases 2 annd 5, the Borda count values are also given in the literature and are in agreement with the computer model results.

For the cases of Table 6, the Copeland (16) results are obtained as the preference order of the model when 0, 1/2, 1 scoring constants are used for

the frequency matrices and -1, 0, 1 scoring constants are used for the preference matrix. The other results are obtained as they were on Table 5. Cases 1, 2, 3, 5, and 6 of Table 6 have total correspondence between literature and computer results from the rank order aggregations. In Case 4, the Copeland results match, but the Borda results do not match. No explanation can be made unless the reference is in error. Nevertheless, the model is validated for the Copeland method.

All six cases in Table 7 have Copeland results from the literature and the model that fully agree.

Case 1 of Table 8 has full agreement between the literature examples and the model results. In Case 2, the rank orders agree but the sublist concordance figures differ because of an error in the sum of the ranks for the F alternative. Dr. Shannon, author of Case 2, told of the error during a class lecture. The majority order of Case 4 agrees with the computed PREF. In Case 5, the intransitive majority agrees with the indifferent orders computed. For Case 6, the last dominated rank order corresponds to and agrees with the computed PREF order. The six cases in Table 8 validate the Shannon preference method in the model.

Table 9 presents special cases to validate specific functions in the model. Case 1 is a Kendall example to illustrate the ties correction calculation of the coefficient of concordance when significant ties (indifferences) are in the sublists. The literature example and the model computation of Case 1 agree completely.

Case 2 is a Kendall example to illustrate the number of circular triads (D) and coefficient of consistency (zeta) computations. The literature example begins with the preference matrix and continues to the completion of the consistency evaluation. The literature example and the model computation of Case 2 agree.

Case 3 is another Kendall example to illustrate the calculation of the Kendall's coefficient of concordance, W. The literature example and the model calculation of the mean, the square of the deviations, and the coefficient of concordance all agree.

In summary, the literature cases and model results in the six tables represent a reasonable validation of the model.

IV. SUMMARY AND RECOMMENDATIONS

A. Concluding Summary

A comprehensive, flexible model was developed and coded on a large computer to accomplish the sublist aggregation, weighting, hierarchial conversions, requirements translation, and results evaluations. The coded model has been verified. Validation has been successfully performed against 46 examples from the literature. The model then was demonstrated for an extensive R & D projects prioritization study (Dobbins 4).

Fuzzy set rank order methodology was briefly explored and added to the model for an alternative final aggregation rank ordering. The methodology employed was too insensitive for many of the cases computed. The fuzzy set method would rank many alternatives as indifferent when the other three methods developed preference orders between the same alternatives.

B. Research Accomplishments

In reflection on the research reported in this report and Dobbins (4, 5) several findings and accomplishments are apparent to this author.

This research demonstrated the practicality and limitations of several majority rule methods that can be used to aggregate ordinal rank orders. Although extensive theoretical research has strived and generally failed to find aggregation methods that always give transitive results, for the realistic rank order problems examined, intransitivity was not an impediment.

This research demonstrated the power and limitations of a large computer capability. Impressive problems, beyond the reasonable consideration of hand calculation, can be accurately and quickly computed when iterative solutions are not involved. But the state of knowledge and equipment limits the

extent of usefulness of majority rule methods to not over a few hundred judges and alternatives.

Specifically, this work has shown that diverse and complex R & D management priority lists can be aggregated into a useful single rank ordered list.

C. Recommendations for Future Investigations

Several areas exist for further research work to improve the modeling and computer coding for the aggregation of rank orders.

The dimensions of the computer code arrays are limited by the computer capacity. With no significant changes in the model, the present 100 x 100 dimension limit could be enlarged to 125 x 125 or perhaps 140 x 140, but little further. The beneficial solution would be a computer code that was not dimension limited. The approach might be to develop a computer code that will progress through very large matrices one section at a time until all sections are computed.

The present model, to minimize data storage requirements, does not hold input sublist data as the computations progress through the arrays. This space saving requires that all data be re-input for each problem even if only a single control value changed. Again, extended space capacity could remedy this input data repetition requirement. Further research might find other remedies.

The COMPARE subroutine used Kendall's concordance tests to evaluate pairs of final aggregated rank orders. Kendall's concordance method is necessary where more than two rank orders are evaluated. But there are other methods, such as the Kendall's Tau method, where there are only two rank orders, that could be considered. An investigation could determine if the Kendall's concordance test should be replaced for these final comparative tests.

APPENDIX A

FUNCTIONAL FLOW DIAGRAM

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The functional flow diagram for the aggregation computer model is presented in Figure A-1. The P term repeated in the flow means "print" the information about that step in the process.

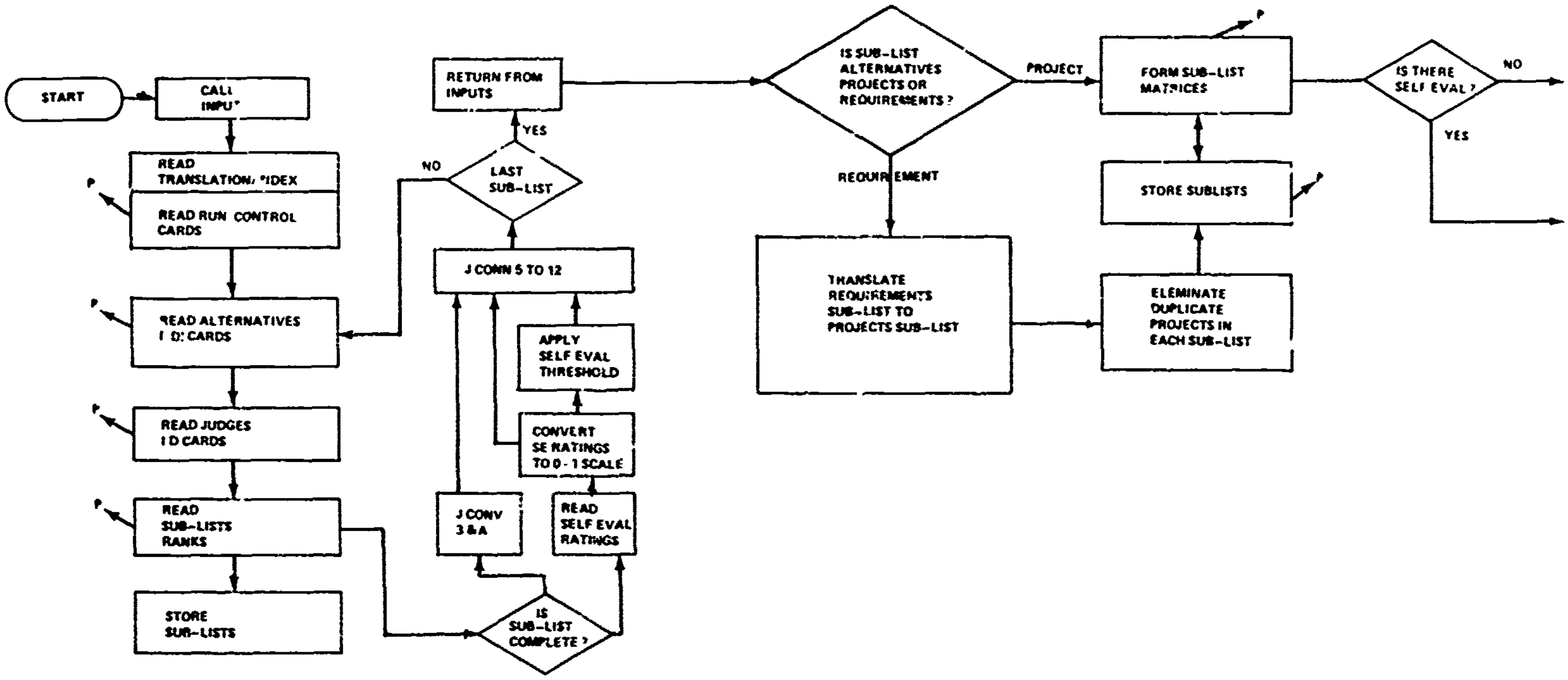

Figure A-1. Model functional flow diagram.

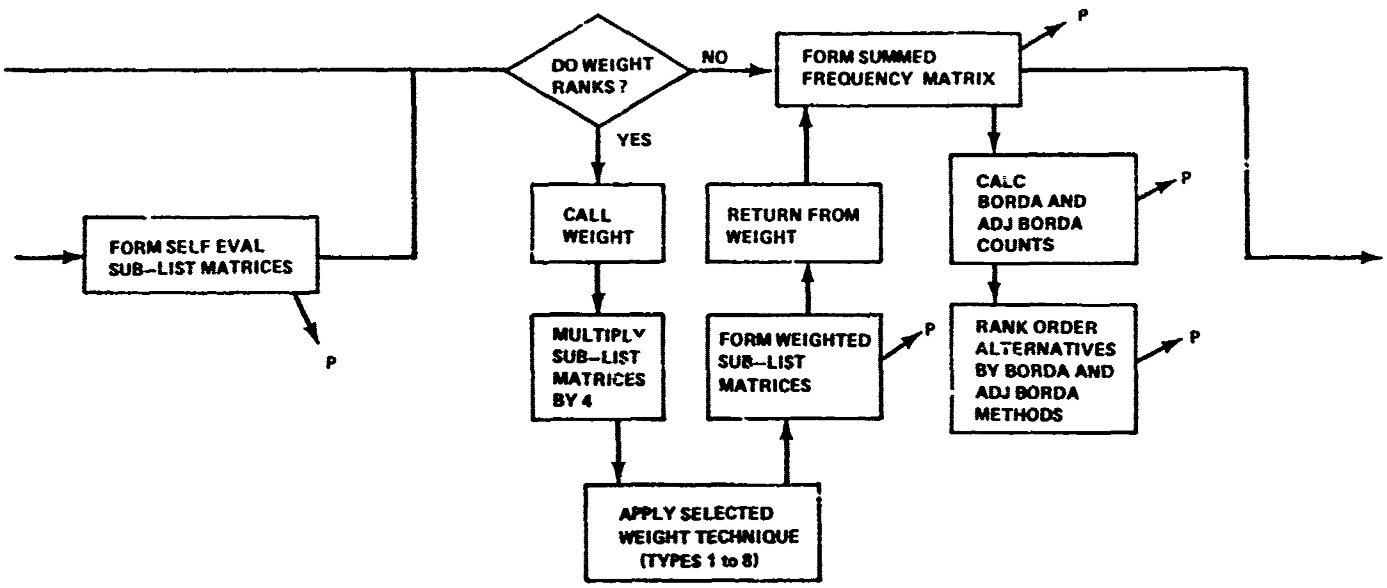

Figure A-1. (Continued).

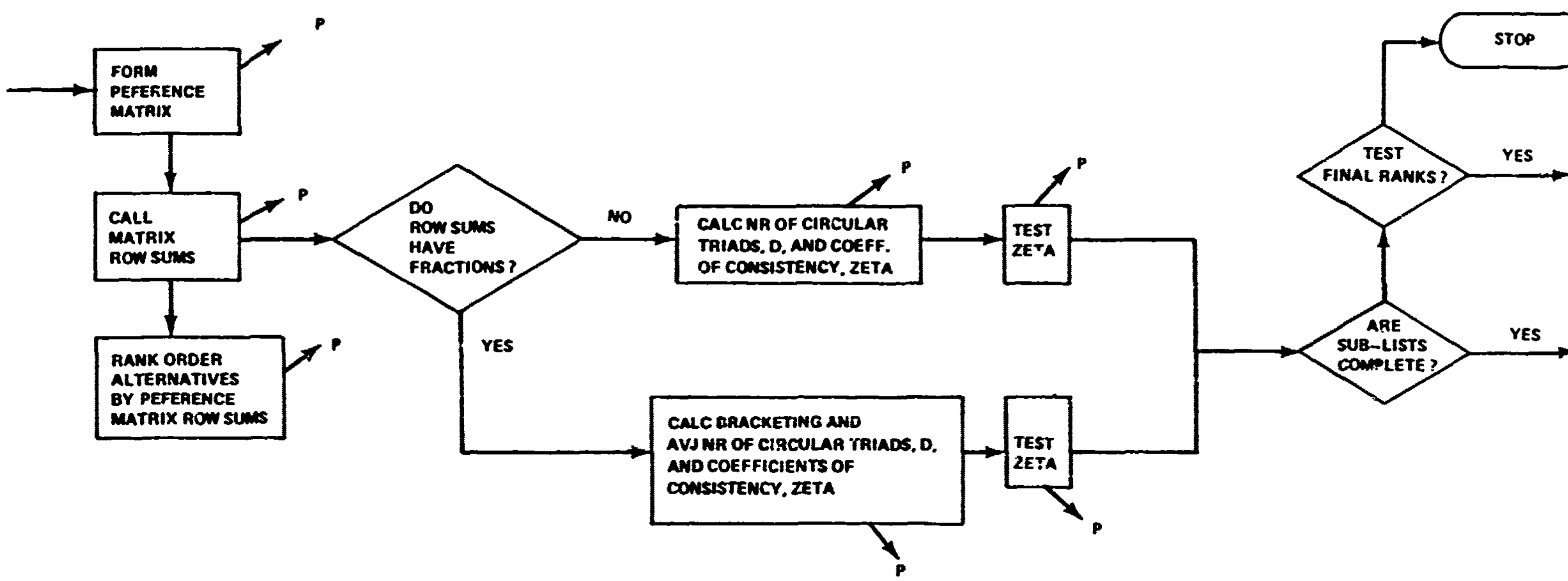

Figure A-1. (Continued).

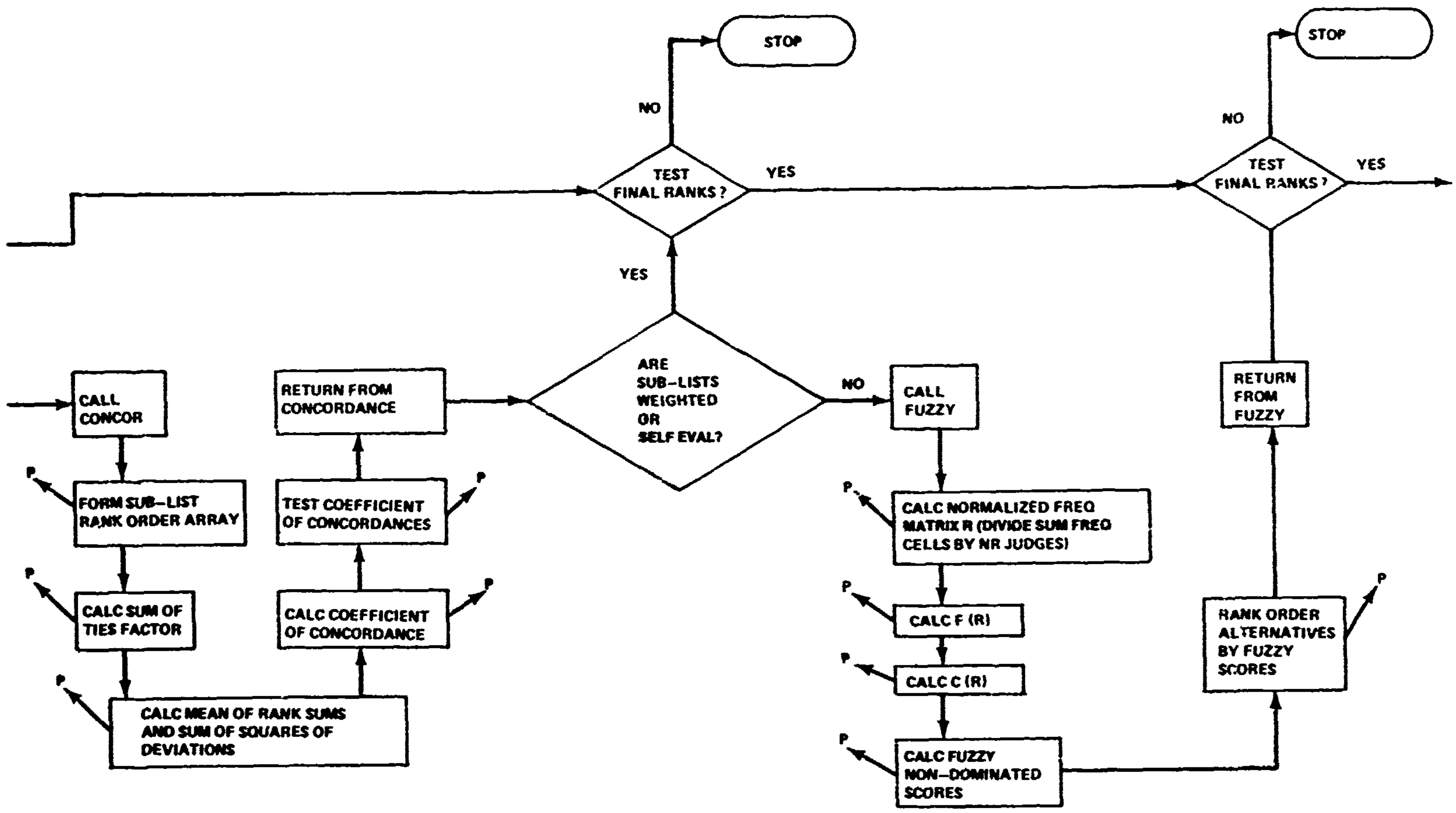

Figure A-1. (Continued).

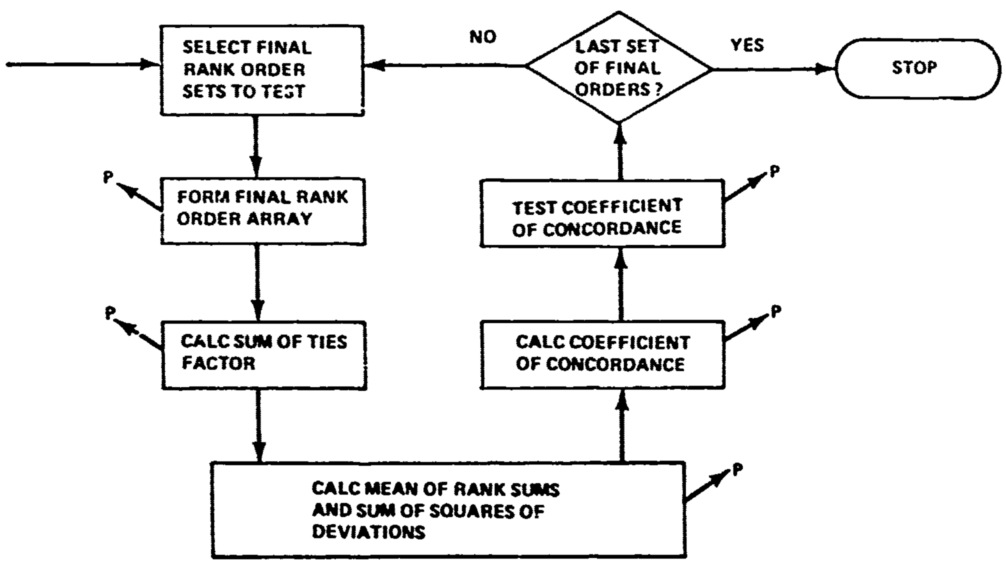

Figure A-1. (Concluded).

APPENDIX B

INPUT INSTRUCTIONS

Input instructions for leading the controls and data into the model are presented in Table B-1.

TABLE B-1. TECHNOLOGY PLANNING PRIORITIES

Input Requirements

Card Type 1: Header - Name of priority group

Col 01-80

Card Type 2: Control card

Col 05-05 = NWT = Weight type (1-8)

(see SECTION II for descriptions)

Col 10-10 = NCOMP = Complete all matrices if nonzero

Col 15-15 = NPTYP1 = Type of calculation for frequency matrix

0 = 0, .5, 1

1 = -1, 0, 1

Col 20-20 = NPTYP2 = Type of calculation for preference matrix

0 = 0, .5, 1

1 = -1, 0, 1

Col 25-25 = MATR = Self evaluation key

0 = No self evaluation

1 = Self evaluation, complete matrix

2 = Self evaluation, threshhold, reduced matrix

Col 26-30 = THLD = Percentage level under which elements are discarded

Col 35-35 = NPRINT = PRINT control

0 = Print all

1 = No print of sublist frequency matrices

2 = No print of sublist frequency matrices or weighted sublist frequency matrices

3 = Same as NPRINT = 1 plus no print Fuzzy

4 = Same as NPRINT = 2 plus no print Fuzzy

5 = Print only input and output

6 = No print Fuzzy

Card Type 3: Input Type

Col 5 = JELE = Element code

0 = End

TABLE B-1. (Continued)

1 = Requirements

2 = Projects

Col 10-20 = NELE = Element type name

Card Type 4: 1 - NBR NBR = Number of requirements

Col 03-05 = K = Element number - Number between 1 - NBR

Col 11-30 = NAM = Element name

Col 31-40 = WHI = Row weight

Col 41-50 = KAT = Category

Terminate element cards with "END" in Col 11-13

A. Element number and name are required. If the weight or category factors are blank, they are assumed to be 0.

B. If a weight type is assigned in Card Type 2, a weight factor must appear on the project card. If the projects are not weighted, but the judges are, then use a one (1) on each card.

Categories are used only in the cases where one or more of the evaluators uses a judge conversion factor of 9, 10, 11, or 12. In which case the CATEGORY (KAT) groups certain projects or requirements together. If the projects within a category are ranked, they must appear in their ranked order.

Element Number	1	2	3	4	5	6	7
Element Name	A	B	C	D	E	F	G
Element Weight							
Element Category	1	1	2	2	2	3	3

The foregoing example implies that 1>2, 3>4>5, 6>7.

The final order of the requirements would depend upon the ranked or unranked state of the categories. If, however, the requirements are specified unranked, then the foregoing example would imply

1 = 2, 3 = 4 = 5, 6 = 7

and again the final order of the requirements would depend upon

TABLE B-1. (Continued)

the ranked or unranked condition of the categories.

Sublist Data Card Sets

Card Type 5: Card 1

Col 01-10 = Judge = Name of judges or office making rank

Col 14-15 = JCONV = 15 Type of project conversion (see Appendix B for descriptions)

Col 16-20 = WTJ = Weight factor of judge

Col 21-25 = ISEM = 100 percent weight factor for self evaluation

A. Judge Name - Name of evaluator must be present. If the JCONV or WJT left blank, they are assumed to be zero.

B. If the JCONV is specified, the program looks for specific data in Card 2 - Free format sublists.

JCONV		Input Requirement
1		Normal input
2		Reduced sublist
3		Input reduced sublist. Program will complete it at end with equal elements all less than the last given element.
4		Input reduced sublist. Program will complete SL at the beginning with equal elements all greater than the first given element.
5		Input rating values in real numbers given in the order of project, e.g., A B C 1, 2, 3, etc. Program will arrange projects in order of highest to lowest, setting equivalent elements equal.
6		Input Julian date of projects in order of projects. Program will arrange projects in order of soonest to latest, setting equivalent elements equal.
7	Input-3	Freeform sublists
	Card A	Key element
	Card B	Secondary array to be inserted into primary array after key element.
	Card C	Primary array - Program inserts secondary array in primary array checking for duplication of each element.

TABLE B-1. (Concluded)

8	Input-3	Freeform sublists
	Card A	Key element
	Card B	Secondary array to be inserted into primary array before key element.
	Card C	Primary array - Program inserts secondary array in primary array checking for duplication of each element.
9-12		Categories must be specified in project cards.
9		Input ranked categories - Categories must not be equal. Program checks for ranking, then groups ranked requirements by category.
10		Input unranked categories - Categories must be equal. Program checks for ranking, then groups ranked requirements by category.
11		Input ranked categories - Categories must not be equal. Program checks for ranking, then groups unranked requirements by category.
12		Input unranked categories - Categories must be equal. Program checks for ranking, then groups unranked requirements by category. (If categories are improperly input, an error message is written and the sublist is dropped from calculations.)

C. If weight type factor appears on Card Type 2, a weight factor must appear on the evaluator card. If projects are weighted, but not the judges, then use a one (1) on each card.

Card Type 6: Card 2 - Free format sublist ranks by project number. Sequence indicates preference, prefix with with minus to indicate equal. Terminate list with an asterisk (*). Follow special rules for specific JCONV outlined above.

Card Type 7: Self evaluation of expertise in the technical field of each input element. These ratings must be between zero and ISEM in the element index order. Use Card Type 7 only when MATR = 1 or 2 (Col 25 Card Type 2). This is a free format list of integers terminated with an asterisk (*).

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APPENDIX C

CODE LISTING

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The FORTRAN IV code listing for the model computer code is presented in Table C-1.

Between each subroutine of the code are reference information about the code to aid in tracing through the logic. Of special benefit is the list of variables and the locations where they will be found in the code.

The key variables are defined in the comments of the subroutines where they are first used. INPUT contains most of the variable definitions.

The INPUT subroutine also contains comments which specify the formats of the input card types.

TABLE C-1.

```
PROGRAM DOBBINS    74/74    OPT=1 TRACE                    FTN 4.6+439        C-/66/80  15.10.36

      PROGRAM DOBBINS(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE9)
C
C         TECHNOLOGY PLANNING PRIORITIES
C
C                             JOB 1493   ED DOBBINS / W. JONES
C
C
      COMMON /CDATA/ NBR ,NJ,NWT, NAME(2,300),A(100,100),WI(300),WJ(101)
     *              , JNAME(121),NSIZE(121),JSURL(10,121)
      COMMON/HELP/NV,IND(300),ICAT(300),NAM(2),JCHECK(300),ITT,IMAX,JMAX
      COMMON/RANK/LISTC(100,3),LIST(100),LAB(3)
      COMMON/IOD/HEADER(4),NOTCOM,NPTYP1,NPTYP2,NFUZ,NPRINT,JTIE
      COMMON/  /MATR,THLD,SEM(10,),ESR(100,101)
C
      DIMENSION  SUM(200), ADJR(100)
      DIMENSION IPREF(2,100),JPREF(100),JRANK(100)
      DATA NGT/" >"/,  NEQ/" ="/
      DATA  NDASH/"------"/
   10 READ(5,982)  HEADER
  982 FORMAT( 8A10 )
      IF( EOF( 5 )  .NE.  0.0 )  STOP 777
      WRITE(6,980)  HEADER
  980 FORMAT("1TECHNOLOGY PLANNING PRIORITIES",18X,8A10//)
C
C                    READ
      CALL INPUT
C
C         COMPUTE FREQU        TRIX FOR EACH SUB-LIST
      CALL  FREQ
C
C         PRINT  SUMMED F      NCY MATRIX
      IF (NPRINT.GE.3.AND.NPRINT.LT.7)NFUZ=1
      IF (NPRINT.EQ.5) GO TO 585
      IF (NWT.GE.1.AND.NWT.LT.0) GO TO 500
      IF (JTIE.EQ.1) GO TO 450
C     PRINT SUMMED FREQ MATRIX - JTIE=0, NO WEIGHTS
      WRITE(6,946)  HEADER, ( J , J=1,NBR )
  946 FORMAT ("1SUMMED FREQUENCY MATRIX",20X,8A10,//"     BORDA     ADJ",
     *(T21,18I6))
      WRITE(6,947)  ( NDASH, J=1,NBR )
  947 FORMAT (1X,T20,18A6)
      GO TO 585
  500 IF (JTIE.EQ.1) GO TO 501
C     PRINT SUMMED FREQ MATRIX - JTIE=0, W/WEIGHTS
      WRITE (6,949) HEADER,(J,J=1,NBR)
  949 FORMAT  ("1SUMMED FREQUENCY MATRIX",20X,8A10//," EQUIV    EQUIV",
     *"/," BORDA    ADJ     BORDA   ADJ   ",(T34,15I6))
      WRITE (6,950) (NDASH,J=1,NBR)
  950 FORMAT (1X,T34,15A6)
      GO TO 585
C     PRINT SUMMED FREQ MATRIX - JTIE=1, W/WEIGHTS
  501 WRITE (6,990) HEADER,(J,J=1,NBR)
  990 FORMAT ("1SUMMED FREQUENCY MATRIX",20X,8A10,//" JUDGE INDIFFERENCE
     *  EXISTS",//"    EQUIV",/" ADJ BORDA  ADJ BORDA",(T24,18I6))
      WRITE (6,991) (NDASH,  J=1,NBR)
  991 FORMAT (1X,T24,18A6)
      GO TO 585
```

TABLE C-1. (Continued)

```
PROGRAM DOMINS    74/74    OPT=1 TRACE                    FTN 4.6+439        06/08/80  15.36.16

C     PRINT SUMMED FREQ MATRIX - JTIE=1, NO WEIGHTS
   65 WRITE (6,992) HEADER,(J,J=1,NBR)
  992 FORMAT ("1SUMMED FREQUENCY MATRIX",20X,8A10,//" JUDGE INDIFFERENCE
     * EXISTS",//" ADJ BORDA",(T15,18I6))
      WRITE (6,993) (NDASH,J=1,NBR)
  993 FORMAT (1X,T15,19A6)
  535 CONTINUE
      DO 620 I = 1,NBR
C             BORDA COUNT AND ADJ BORDA
      SUMR = 0.0
      DO 610 J = 1,NBR
  610 SUMR = SUMR + A(I,J)
      SUMC = 0.0
      DO 615 J = 1,NBR
  615 SUMC = SUMC + A(J,I)
      ADJ = SUMR - SUMC
      SUM(I) = SUMR
      ADJR(I) = ADJ
      IF (NPRINT.EQ.5) GO TO 620
      IF (NWT.GE.1.AND.NWT.LT.6) GO TO 600
      GO TO 625
  600 IF (JTIE.EQ.1) GO TO 601
      WRITE (6,951) SUMR,ADJ,SUMR/4.,ADJ/4.,I, (A(I,J),J=1,NBR)
  951 FORMAT (1X,4F7.1,1X,I3,(T35,"I ",15F6.1))
      GO TO 620
  601 WRITE (6,994) ADJ,ADJ/4.,I,(A(I,J),J=1,NBR)
  994 FORMAT (1X,2(F7.1,1X),I3,(T22,"I ",19F6.1))
      GO TO 620
  625 CONTINUE
      IF (JTIE.EQ.1) GO TO 602
      WRITE(6,968)  SUMR, ADJ, I, ( A(I,J) , J=1,NBR )
  968 FORMAT (1X,2F7.1,1X,I3(T22,"I ",19F6.1))
      GO TO 620
  602 WRITE (6,995) ADJ,I,(A(I,J),J=1,NBR)
  995 FORMAT (1X,F7.1,I3,2X,(T13,"I ",19F6.1))
  620 CONTINUE
      IF (JTIE.EQ.1) GO TO 630
C
      CALL  ORDER( "BORDA     " , NBR , SUM )
  630 CONTINUE
      CALL  ORDER( "ADJ       " , NBR , ADJR )
C
C         COMPUTE PREFERENCE MATRIX
      CALL PREF
C
C
C
C     BYPASS IF WEIGHTED  AND INCOMPLETE
      IF (NGTCOM.NE.0) GO TO 15
      IF (NFUZ.NE.0) GO TO 9
      CALL FUZZY
    9 CONTINUE
C
      IF (NPRINT.EQ.5) GO TO 16
      CALL CONCOR
   15 CALL COMPARE
C
```

TABLE C-1. (Continued)

```
         PROGRAM DOBBINS     74/74    OPT=1 TRACE                   FTN 4.6+439        04/09/80  15.35.36

                 C                                                     TPP1      116
                 C                    PRINT PREFERENCE SUMMARY         TPP1      117
                   15 CONTINUE                                         TPP1      118
                      DO 888 J=1,NBR                                   TPP1      119
                      K=LISTC(J,2)                                     TPP1      120
                      L=IABS(K)                                        TPP1      121
                      JRANK(J)=L                                       TPP1      122
                      JPREF(J)=NGT                                     TPP1      123
                      IF (K.LT.0) JPREF(J)=NEQ                         TPP1      124
                  888 CONTINUE                                         TPP1      125
                      JPREF(1)="  "                                    TPP1      126
                      DO 910 I=1,NBR                                   TPP1      127
                      DO 916 J=1,NBR                                   TPP1      128
                      IF (IABS(LISTC(I,2)).EQ.INO(J)) IPREF(1,I)=NAME(1,J)    TPP1      129
                      IF (IABS(LISTC(I,2)).EQ.INO(J)) IPREF(2,I)=NAME(2,J)    TPP1      130
                  910 CONTINUE                                         TPP1      131
                      WRITE (6,945) HEADER                             TPP1      132
                  945 FORMAT (1H1,T40, 8A10,///T40"PREFERENCE RANK ORDER SUMMARY"///)    TPP1      133
                      WRITE (6,962) (JPREF(I),JRANK(I),I=1,NBR)        TPP1      134
                  962 FORMAT("/  ELEMENT INDEX RANK ORDER",/  20(A2,I3))    TPP1      135
                      WRITE (6,960)                                    TPP1      136
                  960 FORMAT   (//T9, "RANK",7X,"PROJECT")             TPP1      137
                      J=1                                              TPP1      138
                      DO 920 I=1,NBR                                   TPP1      139
                      IF (I.NE.1.AND.LISTC(I,2).GT.0) J=J+1            TPP1      140
                      WRITE (6,961) J,IPREF(1,I),IPREF(2,I)            TPP1      141
                  920 CONTINUE                                         TPP1      142
                  961 FORMAT (//T10,I3,5X,2A10)                        TPP1      143
                      GO TO 18                                         TPP1      144
                      END                                              TPP1      145


  CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

       89     I     29 CD 89  SEPARATOR MISSING.  SEPARATOR ASSUMED HERE.



          SYMBOLIC REFERENCE MAP (R=2)

  ENTRY POINTS      DEF LINE      REFERENCES
    8150  DOBBINS       1

  VARIABLES        SN  TYPE          RELOCATION
   1133  A             REAL        ARRAY    CDATA        REFS         6        67        72        88        93        94        91
   7100  ADJ           REAL                              REFS        73      2*80      2*83        88        91
                                                        DEFINED      73
   7472  ADJR          REAL        ARRAY                 REFS        15        98   DEFINED        79
    146  CSR           REAL        ARRAY    //           REFS        13
      0  HEADER        REAL        ARRAY    IOO          REFS        12        22        37        45        92        99       131
                                                        DEFINED      19
   7155  I             INTEGER                           REFS        69        72        74        75      2*80      2*83      2*88
                                                                   2*91     2*120     2*129     2*133     2*139     2*140
```

TABLE C-1. (Continued)

PROGRAM DDBRINS 74/74 OPT=1 TRACE FTN 4.6+439 04/08/80 15.10.36

VARIABLES		SN TYPE		RELOCATION								
					DEFINED	65	126	133	138			
455	IGAT	INTEGER	ARRAY	HELP	REFS	10						
1618	IMAX	INTEGER		HELP	REFS	18						
1	INO	INTEGER	ARRAY	HELP	REFS	10	120	129				
7637	IPREF	INTEGER	ARRAY		REFS	16	2*148	DEFINED	128	129		
1677	ITT	INTEGER		HELP	REFS	18						
7154	J	INTEGER			REFS	37	45	52	59	65	72	80
					83	88	94	119	121	122	128	2*128
					2*129	139	148	DEFINED	37	42	45	48
					52	55	59	62	68	71	95	83
					88	91	118	127	137	139		
1133	JCHECK	INTEGER	ARRAY	HELP	REFS	10						
1611	JMAX	INTEGER		HELP	REFS	18						
25374	JNAME	INTEGER	ARRAY	CDATA	REFS	8						
18147	JPREF	INTEGER	ARRAY		REFS	16	133	DEFINED	122	123	125	
10313	JRANK	INTEGER	ARRAY		REFS	16	133	DEFINED	121			
25786	JSUBL	INTEGER	ARRAY	CDATA	REFS	8						
15	JTIE	INTEGER		IDO	REFS	12	35	43	79	87	94	
7161	K	INTEGER			REFS	128	123	DEFINED	119			
7162	L	INTEGER			REFS	121	DEFINED	120				
628	LAB	INTEGER	ARRAY	RANK	REFS	11						
454	LIST	INTEGER	ARRAY	RANK	REFS	11						
0	LISTC	INTEGER	ARRAY	RANK	REFS	11	119	128	129	139		
0	MATR	INTEGER		/ /	REFS	13						
1131	NAM	INTEGER	ARRAY	HELP	REFS	10						
3	NAME	INTEGER	ARRAY	CDATA	REFS	8	120	129				
4	NBR	INTEGER		CDATA	REFS	8	37	49	45	48	52	55
					59	62	65	69	71	68	43	84
					91	96	98	119	126	127	133	139
6011	NDASH	INTEGER			REFS	48	40	55	62	DEFINED	14	
6614	NEQ	INTEGER			REFS	123	DEFINED	17				
13	NFUZ	INTEGER		IDO	REFS	12	107	DEFINED	32			
6607	NGT	INTEGER			REFS	122	DEFINED	17				
1	NJ	INTEGER		CDATA	REFS	8						
10	NOTCON	INTEGER		IDO	REFS	12	136					
14	NPRINT	INTEGER		IDO	REFS	12	2*32	33	76	111		
11	NPTYP1	INTEGER		IDO	REFS	12						
12	NPTYP2	INTEGER		IDO	REFS	12						
25541	NSIZE	INTEGER	ARRAY	CDATA	REFS	8						
1	NV	INTEGER		HELP	REFS	10						
2	NNT	INTEGER		CDATA	REFS	9	2*34	2*77				
2	SEM	REAL	ARRAY	/ /	REFS	13						
7163	SUM	REAL	ARRAY		REFS	15	96	DEFINED	74			
7157	SUMB	REAL			REFS	72	73	DEFINED	70	72		
7156	SUMR	REAL			REFS	69	73	76	2*93	84		
					DEFINED	67	69					
1	TWLD	REAL		/ /	REFS	13						
24993	WI	REAL	ARRAY	CDATA	REFS	8						
25227	WJ	REAL	ARRAY	CDATA	REFS	8						

FILE NAMES		MODE										
0	INPUT											
2843	OUTPUT											
0	TAPE5	FMT		READS	19							
2843	TAPE6	FMT		WRITES	22	37	40	45	48	52	55	59
				62	90	93	99	91	131	133	145	148
4186	TAPE9											

TABLE C-1. (Continued)

```
        PROGRAM D7BYINS     74/74    OPT=1 TRACE                     FTN 4.6+439        84/08/98  15.18.36

  EXTERNALS           TYPE    ARGS        REFERENCES
          COMPARF              2             113
          CONCOM               0             112
          EOF         REAL     1              21
          FREQ                 8              29
          FUZZY                6             189
          INPUT                9              26
          ORDER                3              96        98
          PREP                 0             101

  INLINE FUNCTIONS    TYPE    ARGS         DEF LINE  REFERENCES
          IABS        INTEGER   1  INTRIN                128        128        129

  STATEMENT LABELS                    DEF LINE    REFERENCES
     [illegible]  9                     109        107
     6151  10                            19        143
     [illegible]  15                    113        106
     6467  16                           117        111
     8272  458                           59         35
     6226  500                           43         34
     [illegible]  502                    92         43
     6312  555                           64         33        42        51        57
     [illegible]  600                    79         77
     6373  601                           83         79
     [illegible]  602                    91         87
        0  610                           69         69
        0  615                           72         71
     6451  621                           93         65        76        82        85        98
     [illegible]  625                    86         74
     6456  635                           97         94
        0  [illegible]                  124        110
        6  81[illegible]                13[illegible]        126       127
        0  [illegible]                  141        130
     6625  903       FMT                 23         22
     [illegible]  902       FMT          20         19
     7184  945       FMT                132        131
     [illegible]  946       FMT          38         37
     6668  947       FMT                 41         40
     [illegible]  948       FMT          49         49
     6672  949       FMT                 46         45
     [illegible]  95[illegible]       FMT          49         48
     7822  951       FMT                 81         80
     7133  960       FMT                136        135
     7145  961       FMT                142        140
     7122  962       FMT                134        133
     6726  990       FMT                 53         52
     [illegible]  991       FMT          56         55
     6763  992       FMT                 68         59
     7804  993       FMT                 63         62
     78[illegible]  994       FMT        34         83
     7073  995       FMT                 92         91

  LOOPS   LABEL    INDEX       FROM-TO     LENGTH     PROPERTIES
   6218             * J         37 37        48                EXT REFS
   [illegible]      * J         4[illegible] 4[illegible]        48                EXT REFS
   6233             * J         45 45        48                EXT REFS
   [illegible]      * J         [illegible]  48                EXT REFS
```

TABLE C-1. (Continued)

PROGRAM DOBBINS 74/74 OPT=1 TRACE FTN 4.6+439 04/08/80 15.38.35

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
6254		* J	52 52	4B		EXT REFS
5264		* J	55 55	4B		EXT REFS
6275		* J	59 59	4B		EXT REFS
6305		* J	62 62	4B		EXT REFS
6313	620	* I	65 93	140B		EXT REFS NOT INNER
6321	610	J	68 69	3B	INSTACK	
6333	615	J	71 72	3B	INSTACK	
6364		* J	80 80	11B		EXT REFS
6400		* J	83 83	11B		EXT REFS
6420		* J	88 88	11B		EXT REFS
6436		* J	91 91	11B		EXT REFS
6474	800	J	118 124	7B	INSTACK	
6507	810	* I	126 130	23B		NOT INNER
6517	810	J	127 130	10B	OPT	
6537		* I	133 133	10B		EXT REFS
6554	820	* I	138 141	16B		EXT REFS

COMMON BLOCKS	LENGTH
CDATA	21306
HELP	306
RANK	4[illegible]3
IDD	14
/ /	10202

STATISTICS

PROGRAM LENGTH	2314B	1228
BUFFER LENGTH	6151B	3177
CM LABELED COMMON LENGTH	54145B	22629
CM BLANK COMMON LENGTH	23732B	10202

TABLE C-1. (Continued)

```
      74/74    OPT=1 TRACE                 FTN 4.6+439        [illegible]

      INPUT SUBROUTINE                                                 TPP1     146
                                                                       TPP1     147
                KEY VARIABLES                                          TPP1     148
                                                                       TPP1     149
       VARIABLE   AND DISCRIPTION                        SUBROUTINE    TPP1     150
                                                                       TPP1     151
      SUM        = "BORDA" COUNT VARIABLE                DOBBINS       TPP1     152
      ADJP       = "ADJ BORDA" COUNT VARIABLE            DOBBINS       TPP1     153
      NEL        = NUMBER OF ELEMENTS                    INPUT         TPP1     154
      K          = INDEX OF ELEMENT                      INPUT         TPP1     155
      WHIGHT     = ELEMENT WEIGHT FACTOR (ROW)           INPUT         TPP1     156
      KAT        = CATEGORY -ELEMENT GROUP               INPUT         TPP1     157
      KWT        = WEIGHT TYPE-OVERALL WEIGHTING         INPUT         TPP1     158
                   FACTOR                                INPUT         TPP1     159
      NCOMP      = FLAG FOR COMPLETION                   INPUT         TPP1     160
      NPTYP1     = FREQUENCY  MATRIX TYPE CONVERSION     INPUT         TPP1     161
      NPTYP2     = PREFERENCE MATRIX TYPE CONVERSION     INPUT         TPP1     162
      NATR       = JUDGE SELF EVALUATION FLAG            INPUT         TPP1     163
      THLD       = PERCENT LEVEL UNDER WHICH THE         INPUT         TPP1     164
                   ELEMENTS ARE DISCARDED                INPUT         TPP1     165
      NPRINT     = PRINT CONTROL FLAG                    INPUT         TPP1     166
      JUDGE      = NAME OF EVALUATOR                     INPUT         TPP1     167
      JCONV      = JUDGE CONVERSION KEY TO ARRANGE       INPUT         TPP1     168
                   DATA INTO STANDARD FORMAT             INPUT         TPP1     169
      WTJUDJJ    = JUDGE WEIGHT FACTOR (COLLUM)          INPUT         TPP1     170
      ISEN       = 100 PERCENT WEIGHT FACTOR FOR SELF    INPUT         TPP1     171
                   EVALUATION                            INPUT         TPP1     172
      JELE       = CODE FOR INPUT TYPE,E.G.,PROJECTS     INPUT         TPP1     173
                   OR REQUIREMENTS                       INPUT         TPP1     174
      ESR        = JUDGE SELF EVALUATION PERCENTAGE      INPUT         TPP1     175
      FVALUE     = FORMATED OUTPUT FROM PRAN             INPUT         TPP1     176
      C          = KEY ELEMENT FOR JCONV-97 OR 0         INPUT         TPP1     177
      IMAX       = MAXIMUM NUMBER OF ELEMENTS            INPUT         TPP1     178
      IND        = ARRAY OF INDEXES OF ELEMENTS          INPUT         TPP1     179
      ITT        = TOTAL NUMBER OF PROJECTS              INPUT         TPP1     180
      JMAX       = MAXIMUM NUMBER OF JUDGES              INPUT         TPP1     181
      JNAME      = ARRAY OF JUDGES' NAMES                INPUT         TPP1     182
      JPREF      = ARRAY OF +95 AND +95 FOR EACH RANK    INPUT         TPP1     183
                   ORDER                                 INPUT         TPP1     184
      JRANK      = ARRAY OF RAN  ORDER                   INPUT         TPP1     185
      JSUM       = ARRAY OF ALL  JUDGES' RANK ORDER      INPUT         TPP1     186
      NAME       = ARRAY OF ELEMENT NAMES                INPUT         TPP1     187
      NFUZ       = FLAG TO OMIT FUZZY                    INPUT         TPP1     188
      NJ         = NUMBER OF JUDGES                      INPUT         TPP1     189
      NSIZE      = ARRAY OF THE NUMBER OF ELEMENTS       INPUT         TPP1     190
                   EACH JUDGE RANKED                     INPUT         TPP1     191
      NF         = NUMBER OF ELEMENTS FOUND BY PRAN      INPUT         TPP1     192
                   IN EACH RANK ORDER                    INPUT         TPP1     193
      SEN        = ARRAY OF SELFEV EVALUATION VALUES     INPUT         TPP1     194
                   READ BY PRAN                          INPUT         TPP1     195
      WI         = ARRAY  OF ELEMENT WEIGHTS             INPUT         TPP1     196
      WJ         = ARRAY  OF JUDGE   WEIGHTS             INPUT         TPP1     197
      LIST       = ARRAY OF ELEMENTS FOR COMPOSITE RANK  ORDER         TPP1     198
                   ORDER                                 ORDER         TPP1     199
      LISTC      = ARRAY OF ELEMENTS FOR THE THREE       ORDER         TPP1     200
                   COMPOSITE RANK ORDERS                 ORDER         TPP1     201
      LAB        = NAME OF THE COMPOSITE RANK ORDERS     ORDER         TPP1     202
```

TABLE C-1. (Continued)

```
            74/74    OPT=1 TRACE                    FTN 4.6+439        04/08/80  15.38.36

      C          CS       = CHI-SQUARE STATISTIC                       PREF      TPP1    203
      C          D        = KENDALL D AND OF CIRCULAR TRIADS IN        PREF      TPP1    204
      C                     PREF                                       PREF      TPP1    205
      C          DS       = VALUES OF KENDALL D AT RANGE LEVELS        PREF      TPP1    206
      C          LAB      = LABEL FOR RANGE OF KENDALL  D              PREF      TPP1    207
      C          GNU      = DEGREES OF FREEDOM                         PREF      TPP1    208
      C          NF       = NUMBER OF FRACTIONAL SUMS                  PREF      TPP1    209
      C          P        = PROBABILITY THAT RANK IS NOT CONSISTANT    PREF      TPP1    210
      C          PTEST    = FIXED CRITICAL VALUE OF P                  PREF      TPP1    211
      C          ZETA     = COEFFICIENT OF CONSISTANCY                 PREF      TPP1    212
      C          A(I,J)   = NORMALIZED FREQUENCY MATRIX, R             FUZZY     TPP1    213
      C          TRACFC   = SUM OF THE MAJOR DIAGONAL OF A(I,J)        FUZZY     TPP1    214
      C                     MATRIX  SQUARED                            FUZZY     TPP1    215
      C          TRACE E  = SUM OF THE MAJOR DIAGONAL OF A(I,J)        FUZZY     TPP1    216
      C                     MATRIX * A(I,J)  TRANSPOSED                FUZZY     TPP1    217
      C          FR       =  AVERAGE FUZZINESS IN R                    FUZZY     TPP1    218
      C          CR       =  AVERAGE CERTAINTY IN R                    FUZZY     TPP1    219
      C          S        = SUM OF DEVIATIONS SQUARED                  CONCOR    TPP1    220
      C          C        = KENDALLS COEFFICIENT OF CONCORDANCE        CONCOR    TPP1    221
      C          RBAR     = MEAN                                       CONCOR    TPP1    222
      C          P        = PROBABILITY OF RANK ORDER CONCORDANCE      CONCOR    TPP1    223
      C          NELE     = NUMBER OF ENTRIES ON INDEX                 REQUIRE   TPP1    224
      C                                                                          TPP1    225
      C***    INPUT DATA    ***                                                  TPP1    226
      C                                                                          TPP1    227
      C** CARDS  1 THRU NBR                    NBR = NUMBER OF PROJECTS          TPP1    228
      C     COL 03-05  = K  = ELEMENT NUMBER.  NUMBER BETWEEN 1 AND NBR.         TPP1    229
      C         11-30  =  NAM= ELEMENT NAME.                                     TPP1    230
      C         36-40 = WHI = ROW WEIGHT       F5.0                              TPP1    231
      C         46-50 = KAT = CATEGORY         I5                                TPP1    232
      C     TERMINATE PROJECT CARDS WITH "END" IN COLS 11-13.                    TPP1    233
      C                                                                          TPP1    234
      C**   CONTROL CARD                                                         TPP1    235
      C     COL 05-05 = NWT = WEIGHT TYPE  1 THRU 4                              TPP1    236
      C                 0 = NO WEIGHTS                                           TPP1    237
      C     COL 10-10 = NCOMP= COMPLETE ALL MATRICES IF NON ZERO                 TPP1    238
      C     COL 15-15 = NPTYP1 - FREQUENCY MATRIX TYPE CONVERSION                TPP1    239
      C     COL 20-20 = NPTYP2 - PREFERENCE MATRIX TYPE CONVERSION               TPP1    240
      C                         0 = 0,.5,1                                       TPP1    241
      C                         1 = -1,0,1                                       TPP1    242
      C     COL 25-25 = MAIR - SELF EVALUATION KEY                               TPP1    243
      C                         0 = NO SELF-EVALUATION                           TPP1    244
      C                         1 = SELF EVALUATION COMPLETE MATRIX              TPP1    245
      C                         2 = SELFEVALUATION THRESH HOLD REDUCED MATRIX    TPP1    246
      C         26-30 = THLD - LEVEL UNDER WHICH THE ELEMENTS ARE DISCARDED      TPP1    247
      C      COL 31-35 = NPRINT - NO PRINT KEY-                                  TPP1    248
      C                          0 = PRINT ALL                                   TPP1    249
      C                          1 = NO PRINT OF SUB-LIST FREQUENCY MATRICES     TPP1    250
      C                          2 = NO PRINT OF SUB-LIST FREQUENCY MATRICES     TPP1    251
      C                              OR WEIGHTED SUB-LIST FREQUENCY MATRICES     TPP1    252
      C                          3 = SAME AS NPRINT  = 1 PLUS NO PRINT FUZZY     TPP1    253
      C                          4 = SAME AS NPRINT =2 PLUS NO PRINT FUZZY       TPP1    254
      C                          5 = PRINT ONLY INPUT AND OUTPUT                 TPP1    255
      C                          6 = NO PRINT FUZZY                              TPP1    256
      C                                                                          TPP1    257
      C** SUB-LIST DATA CARD-SETS **                                             TPP1    258
      C     CARD 1                                                               TPP1    259
```

TABLE C-1. (Continued)

```
                74/74   OPT=1 TRACE                  FTN 4.6+439          06/08/80  15.18.36

C      COL 01-10 = JUDGE = NAME OF JUDGE OR OFFICE MAKING RANK  A10
C      COL 14-15 = JCONV = TYPE OF PROJECT CONVERSION            I5
C      COL 16-20 = WTJ   = WEIGHT FACTOR OF JUDGE                F5.0
C      COL 21-25 = ISEM - 100 PERCENT WEIGHT FACTOR FOR SELF EVALUATION
C
C      CARD 2 = FREE FORMAT JOB-LIST RANKS BY PROJECT NUMBER.
C               SEQUENCE INDICATES PREFERENCE. PREFEX WITH MINUS TO
C               INDICATE EQUAL. TERMINATE LIST WITH AN *.
C
C     CARD 3 = FREE FORMAT SELF EVALUATION LEVELS. ONE FOR EACH RANKED
C             ITEM IN ORDER. MUST BE LESS THAN OR EQUAL TO ISEM. LIST
C             MUST BE ENDED WITH AN *.
C
       SUBROUTINE INPUT
C
       COMMCN /CDATA/ NBR ,NJ,NNT, NAME(2,300),A(100,100),WI(300),WJ(100)
     *                , JNAME(101),NSIZE(101),JSUBL(100,101)
       COMMCN/IDD/HEADER(8),NOTCOM,NPTYP1,NPTYP2,NFUZ,NPRINT,JTIE
       COMMCN/HELP/NY,IND(300),ICAT(300),NAM(2),JCHECK(300),ITT,IMAX,JMAX
       COMMON/  /MATR,THLO,SEM(100),ESR(100,101)
       COMMCN /WORK/X(100,100),SUMA(300),JRANK(100),JPREF(100)
       DIMENSION SUMB(300)
C
       REAL  EVALUE(100)
       LOGICAL  ERROR,  JERR,  EOF
       DATA   ERROR/.FALSE./ , JERR/.FALSE./
       DATA  NGT/" -"/, NEQ/" ="/
C          CLEAR DATA
       JMAX=100
       IMAX=300
       ERROR = .FALSE.
       N = 0
       NOTCOM = 0
       DO 10 J=1,IMAX
       WI(J)=1.
       IND(J)=0
    10 ICAT(J)=0
       DO 11 J=1,JMAX
       WJ(J)=1.
       DO 11 I=1,JMAX
    11 A(I,J)=0.0
       NJ = 0
       DO 15 K = 1,101
       JNAME(K) = 1H
       NSIZE(K) = 0
       DO 15 J=1,100
       ESR(J,K)=5.
    15 JSUBL(J,K) = 0
C
C              READ CONTROLS
       READ (5,912) NNT,NCOMP,NPTYP1,NPTYP2,MATR,THLO,NPRINT
       WRITE (6,914) NNT,NPTYP1,NPTYP2,MATR,THLO,NPRINT
   912 FORMAT(5I3,F5.2,I5)
   914 FORMAT(/" NNT=",I2,3X,"NPTYP1=",I2,3X,"NPTYP2=",I2,3X,"MATR=",I2,3
     *X,"THLO=",F4.2,3X,"NPRINT="I2/)
       IF( NCOMP .NE. 0 )  HEADER(8) = " COMPLETED"
       IF( NCOMP .NE. 0 )  WRITE(6,915)
```

TABLE C-1. (Continued)

```
      SUBROUTINE INPUT       74/74    OPT=1 TRACE                  FTN 4.6+439          04/08/80  15.38.36

  915 FORMAT(/" COMPLETE ALL SUB-LISTS"/)
      IF( NWT .GE. 0  .OR.  NWT .LE. 4 )  GO TO 70
      WRITE(6,918)  NWT
  918 FORMAT("+",T55,"** ERROR **"I3," IS ILLEGAL WEIGHT TYPE")
      NWT = 0
    7 CONTINUE
      ITT=0
      JNJ=0
      INJ=0
      NFUZ=0
C            BYPASS FUZZY IF WEIGHTED
      IF (NWT.NE.0) NFUZ=1
C            END OF WEIGHTS
C
  400 CONTINUE
      READ (5,900) JELE,NELE
      IF (JELE.EQ.0.AND.JNJ.GT.INJ) NOTCCM=1
      IF (JELE.EQ.0) NBR=ITT
      IF (JELE.EQ.0) GO TO 777
  900 FORMAT (I5,5X,A10)
      WRITE (6,901) NELE
  901 FORMAT (/" INPUT READ IN ",A10/)
      WRITE(6,902)
  902 FORMAT (/"  INDEX      ELEMENT NAME",14X,"WT",10X,"CAT"/)
C     READ ELEMENT  INDEX, NAMES, WEIGHTS, CATEGORIES
   17 READ (5,904) K,NAM,WHI,KAT
  904 FORMAT (1X,I4,5X,2A10,5X,F5.0,5X,I5)
      WRITE (6,904) K,NAM,WHI,KAT
      IF( NAM(1) .EQ. "END" .OR.  K .EQ. 999 )  GO TO 50
      IF (JELE.EQ.2) ITT=K
      IF (JELE.EQ.1) K=ITT+K
      IF (K.LE.IMAX) GO TO 20
      WRITE (6,906) IMAX
  906 FORMAT("+",T55,"** ERROR ** INDEX LARGER THAN"I4)
      ERROR = .TRUE.
      GO TO 40
   20 IF( K .GT. 0 )  GO TO 25
      WRITE(6,907)
  907 FORMAT("+",T55,"** ERROR ** INDEX LESS THAN 1")
      ERROR = .TRUE.
      GO TO 40
   25 IF( IND(K) .EQ. 0 ) GO TO 30
      WRITE(6,908)  K, NAME(1,K), NAME(2,K)
  908 FORMAT("+",T55,"** ERROR ** INDEX"I4 ," HAS ALREADY BEEN DEFINED",
     * " AS ",2A10)
      ERROR = .TRUE.
      GO TO 40
C
   30 IND(K) = K
      ICAT(K)=KAT
      NAME(1,K) = NAM(1)
      NAME(2,K) = NAM(2)
      N=MAX0(N,K)
      IF( WHI .NE. 0. )  WI(K) = WHI
      IF( NWT .EQ. 7  )  WI(K) = NWT
   40 GO TO 17
C
```

TABLE C-1. (Continued)

```
SUBROUTINE INPUT      74/74    OPT=1 TRACE                    FTN 4.6+439        04/08/80  15.34.36

          59 NBR = N
             IF (JELE.EQ.1) NBR=NBR-1
             DO 60 J=1,NBR
             IF( IND(J) .GT. 0 )  GO TO 60
             WRITE(6,910)  J
         910 FORMAT (" **ERROR** WHAT IS ELEMENT NAME FOR INDEX",I4)
             ERROR = .TRUE.
          60 CONTINUE
C
         120 CONTINUE
C
             WRITE(6,941)    HEADER
         941 FORMAT("1",8A10/)
C                  READ SUB-LIST RANKS AND JUDGES
         500 CONTINUE
             READ (5,930) JUDGE, JCONV, WHJ, ISEM
         930 FORMAT (A10,I5,F5.0,I5)
             IF (JUDGE.EQ."END") GO TO 490
             IF (JCONV.EQ.999) GO TO 480
             WRITE (6,932) JUDGE,JCONV,WHJ,ISEM
         932 FORMAT(//"0",A10,4X,"JCONV =",I5,4X,"JUDGE WEIGHT =",F6.1,4X,"JSE
            *VALUE LIMIT =",I5)
             IF( WHJ .EQ. 0.  .AND.  NNT .NE. 7 )  WHJ = 1.0
             IF (MATR.NE.0) NFUZ=1
C
             DO 502 J=1,NBR
             JRANK(J)  = 0
         502 JCHECK(J) = 0
             JERR = .FALSE.
C
             PRINT 1,NBR,(NJ+1)
           1 FORMAT (/1X,"TOTAL NBR ALT =",I5,5X,"NR THIS JUDGE =",I5)
             IF (JCONV.GT.5) GO TO 800
             IF (JCONV.EQ.7.OR.JCONV.EQ.8) GO TO 700
             CALL PRAN (FVALUE,NV,-NBR)
C                  READ FREE FORMAT DATA, END SUB-LIST WITH *
C                  CONVERT TO INTEGER
             IF (JCONV.EQ.5.OR.JCONV.EQ.6) GO TO 603
         565 CONTINUE
             DO 510 J=1,NV
             K = FVALUE(J)
             L = IABS(K)
             IF( L .GT. 0  .AND.  L .LE. NBR )  GO TO 505
             WRITE(6,934)  J, K
         934 FORMAT(" ** ERROR ** ENTRY NUMBER,"I4," HAS ILLIGAL PROJECT/"
            * "PRODUCT OF",I5 )
             ERROR = .TRUE.
             JERR = .TRUE.
         505 IF( JCHECK(L) .EQ. 0 )  GO TO 508
             WRITE(6,933) K
         933 FORMAT(" ** ERROR **",I5," ALREADY RANKED")
             ERROR = .TRUE.
             JERR = .TRUE.
             GO TO 510
C
         508 JRANK(J) = L
             JPREF(J) = NGT
```

TABLE C-1. (Continued)

```
      SUBROUTINE INPUT      74/74    OPT=1 TRACE                FTN 4.6+439          34/05/43  15.38.36

            JCHECK(L) = L
            IF( K .LT. 0 )  JPREF(J) = NEG
        510 CONTINUE
            JPREF(1) = " "
      C
            WRITE(6,942)            ( JPREF(J), JRANK(J), J=1,NV )
        942 FORMAT(/       /(26(A2,I3)//))
      C
      C            CHECK FOR COMPLETE SUB-LIST
            FLAG = 0
            DO 512 J = 1,NBR
        512 IF( JCHECK(J) .EQ. 0 )  FLAG = 1
            IF (FLAG.NE.0) JNJ=JNJ+1
            IF( FLAG .NE. 0 )  WRITE(6,940)
        940 FORMAT (/" SUBLIST IS INCOMPLETE")
      C
            IF( JERR )  GO TO 500
      C         STORE SUB-LIST
            NJ = NJ + 1
            JNAME(NJ) = JUDGE
            NSIZE(NJ) = NV
            WJ(NJ) = WHJ
            DO 515 J = 1,NV
        515 JSUBL(J,NJ) = FVALUE(J)
      C     JCONV=2   SUBLIST NOT COMPLETED
            IF (JCONV.EQ.2) NOTCOM=1
            IF (JCONV.EQ.2) GO TO 54C
            IF (JCONV.EQ.3.AND.MATR.NE.0.OR.JCONV.EQ.4.AND.MATR.NE.0)
           *WRITE (6,920)
        920 FORMAT(/" SELF EVALUATION PROHIBITS COMPLETION"/)
            IF (MATR.NE.0) GO TO 534
            IF (JCONV.EQ.3.OR.JCONV.EQ.4) GO TO 516
      C
      C          COMPLETE SUB-LIST
            IF( KCOMP .EQ. 0    )  GO TO 540
        516 CONTINUE
            IF( NV     .GE. NBR )  GO TO 540
      C
            IF (JCONV.EQ.3.OR.JCONV.EQ.4) INJ=INJ+1
            IF (JCONV.NE.4) GO TO 519
      C      JCONV=4
      C      MOVE OVER FOR LEFT INSERT
            DO 519 J=1,NV
            K1=NBR-J+1
            K2=NV-J+1
        519 JSUBL(K1,NJ)=JSUBL(K2,NJ)
            M=J
            DO 514 J=1,NBR
            DO 513 L=K1,NBR
            IF (J.EQ.IABS(JSUBL(L,NJ)))GO TO 514
        513 CONTINUE
            M=M+1
            JSUBL(M,NJ)=-J
        514 CONTINUE
            JSUBL(1,NJ)=IABS(JSUBL(1,NJ))
            NV=NBR
            GO TO 532
```

TABLE C-1. (Continued)

```
SUBROUTINE INPUT      74/74    OPT=1 TRACE              FTN 4.6+439       04/08/84  15.38.36

             519 CONTINUE
           C     JCONV=3
           C     RIGHT INSERT
                 NVV = NV
                 DO 530 K=1,NBR
                 DO 528 J=1,NV
                 IF( K .EQ. IABS( JSUBL(J,NJ) ) )  GO TO 535
             529 CONTINUE
                 NVV = NVV + 1
                 JSUBL(NVV,NJ) = - K
             530 CONTINUE
                 JSUBL(NV+1,NJ) = IABS(  JSUBL(NV+1,NJ)  )
             532 CONTINUE
                 NSIZE(NJ) = NVV
                 NV = NVV
           C
             540 CONTINUE
           C     SELF EVALUATION
             534 CONTINUE
                 IF (MATR.EQ.0) GO TO 525
                 CALL PRAM (SEM,NV,-NBR)
                 DO 555 I=1,NV
                 IF (SEM(I).GT.1SEM) GO TO 556
             555 CONTINUE
                 GO TO 557
             556 WRITE (6,921)
             921 FORMAT (" ***ERROR*** SELF EVALUATION LEVEL GREATER THAN 100 PERCE
                *NT")
                 GO TO 525
             557 CONTINUE
                 DO 546 I=1,NV
             546 SEM(I)=SEM(I)/FLOAT(ISEM)
                 DO 547 I=1,NV
                 DO 547 J=1,NV
             547 IF (J.EQ.IABS(JSUBL(I,NJ))) ESR(I,NJ)=SEM(J)
                 WRITE (6,952) (ESR(I,NJ),I=1,NV)
             952 FORMAT (/    /,15(F6.2,3X))
           C     THRESH HOLD MATRIX REDUCTION SELF EVALUATION
                 IF (MATR.EQ.1) GO TO 525
                 DO 549 I=1,NBR
                 IF (ESR(I,NJ).LT.THLD) GO TO 549
                 GO TO 548
             549 IF (JSUBL(I,NJ).GT.0.AND.JSUBL(I+1,NJ).LT.0) JSUBL(I+1,NJ)=IABS(JS
                *UBL(I+1,NJ))
                 JSUBL(I,NJ)=0
             548 CONTINUE
                 M=0
                 DO 553 I=1,NBR
             553 IF (JSUBL(I,NJ).NE.0) M=M+1
             554 K=0
                 DO 550 I=1,NBR
                 IF (JSUBL(I,NJ).EQ.0) GO TO 551
                 GO TO 550
             551 IF (I.GT.M) GO TO 550
                 DO 552 J=I,NBR
                 K=1
             552 JSUBL(J,NJ)=JSUBL(J+1,NJ)
```

TABLE C-1. (Continued)

```
SUBROUTINE INPUT      74/74    OPT=1 TRACE                    FTN 4.6+439          06/08/80  15.30.36

        550 CONTINUE
            IF (K.EQ.1) GO TO 554
            IF (M.NE.NBR) NV=M
            NSIZE(NJ)=NV
            IF (M.NE.NBR) NCOMP=1
        525 CONTINUE
      C     REQUIREMENTS TO PROJECTS TRANSLATION
            IF (JELE.EQ.1) GO TO 1250
            GO TO 500
       1250 CALL REQUIRE
            WRITE (6,951)
        951 FORMAT (//1X,"REQUIREMENTS TO PROJECTS TRANSLATION")
            DO 1000 I=1,NV
       1000 JRANK(I)=0
            DO 1010 J=1,NV
            K=JSUBL(J,NJ)
            L=IABS(K)
            JRANK(J)=L
            JPREF(J)=NGT
            IF (K.LT.0) JPREF(J)=NEQ
       1010 CONTINUE
            JPREF(1)="   "
            WRITE (6,958) (JPREF(J),JRANK(J),J=1,NV)
        958 FORMAT (/        /(26(A2,I3)//))
      C     GO READ MORE DATA
            GO TO 50
        500 CONTINUE
            NVV=NV-1
            DO 601 I=1,NV
        601 SUMA(I)=FLOAT(I)
      C     JCONV=0
      C     CONVERSION OF DATA TO DECENDING ORDER
            IF (JCONV.EQ.6) GO TO 625
            DO 605 I=1,NVV
            M=I+1
            DO 605 J=M,NV
            IF (FVALUE(J).LT.FVALUE(I)) GO TO 605
            HOLD=FVALUE(J)
            SHOLD=SUMA(J)
            FVALUE(J)=FVALUE(I)
            SUMA(J)=SUMA(I)
            FVALUE(I)=HOLD
            SUMA(I)=SHOLD
        605 CONTINUE
            M=0
            DO 603 I=1,NV
            IF (FVALUE(I).EQ.0.) SUMA(I)=0.
            IF (SUMA(I).NE.0.)  M=M+1
        603 CONTINUE
            MM=M-1
            DO 602 I=1,MM
        602 IF (FVALUE(I).EQ.FVALUE(I+1)) SUMA(I+1)=-SUMA(I+1)
            GO TO 650
      C     JCONV=6
      C     CONVERSION OF DATA TO ASCENDING ORDER
        625 DO 610 I=1,NVV
            M=1+I
```

TABLE C-1. (Continued)

```
SUBROUTINE INPUT      74/74    OPT=1 TRACE                    FTN 4.6+439           06/08/80  15.34.36

              DO 613 J=M,NV                                                 TPP1     602
              IF (FVALUE(J).GT.FVALUE(I)) GO TO 613                         TPP1     603
              HOLD=FVALUE(J)                                                TPP1     604
              SHOLD=SUMA(J)                                                 TPP1     605
              FVALUE(J)=FVALUE(I)                                           TPP1     606
              SUMA(J)=SUMA(I)                                               TPP1     607
              FVALUE(I)=HOLD                                                TPP1     608
              SUMA(I)=SHOLD                                                 TPP1     609
          613 CONTINUE                                                      TPP1     610
              M=0                                                           TPP1     611
              DO 612 I=1,NV                                                 TPP1     612
              IF (FVALUE(I).EQ.0.) SUMA(I)=0.                               TPP1     613
              IF (SUMA(I).NE.0.)  M=M+1                                     TPP1     614
          612 CONTINUE                                                      TPP1     615
              MM=M-1                                                        TPP1     616
              DO 611 I=1,MM                                                 TPP1     617
          611 IF (FVALUE(I).EQ.FVALUE(I+1)) SUMA(I+1)=-SUMA(I+1)            TPP1     618
          650  IF (M.NE.NV) NV=M                                            TPP1     619
              DO 651 J=1,NV                                                 TPP1     620
          651 FVALUE(J)=SUMA(J)                                             TPP1     621
              GO TO 545                                                     TPP1     622
          700 CONTINUE                                                      TPP1     623
              CALL PRAM (C,NV,1)                                            TPP1     624
              CALL PRAM(SUMB,NVV,-NBB)                                      TPP1     625
              CALL PRAM (SUMA,NV,-NBB)                                      TPP1     626
              IF (JCONV.NE.7) GO TO 799                                     TPP1     627
         C    JCONV=7   INSERT AFTER KEY REQUIREMENT                        TPP1     628
              DO 731 I=1,NV                                                 TPP1     629
          731 IF (SUMA(I).EQ. C) K=I                                        TPP1     630
              DO 785 I=1,NVV                                                TPP1     631
              DO 785 J=I,K                                                  TPP1     632
          785 IF(SUMA(J).EQ.SUMB(I)) SUMB(I)=0.                             TPP1     633
              DO 702 I=1,K                                                  TPP1     634
          702 FVALUE(I)=SUMA(I)                                             TPP1     635
              NBB=NVV+K                                                     TPP1     636
              DO 703 I=1,NVV                                                TPP1     637
          703 FVALUE(I+K)=SUMB(I)                                           TPP1     638
              NVT=NV+NVV                                                    TPP1     639
              K1=K+1                                                        TPP1     640
              DO 786 I=1,NBB                                                TPP1     641
              DO 786 J=K1,NV                                                TPP1     642
          786 IF (FVALUE(I).EQ.SUMA(J)) SUMA(J)=0.                          TPP1     643
              DO 704 I=K1,NV                                                TPP1     644
          704 FVALUE(I+NVV)=SUMA(I)                                         TPP1     645
              DO 707 I=1,NVT                                                TPP1     646
              IF (FVALUE(I).EQ.0.) GO TO 710                                TPP1     647
              GO TO 707                                                     TPP1     648
          710 DO 711 J=I,NVT                                                TPP1     649
          711 FVALUE(J)=FVALUE(J+1)                                         TPP1     650
          707 CONTINUE                                                      TPP1     651
              M=0                                                           TPP1     652
              DO 715 I=1,NVT                                                TPP1     653
          715 IF (FVALUE(I).NE.0.) M=M+1                                    TPP1     654
              NV=M                                                          TPP1     655
              GO TO 545                                                     TPP1     656
          799 CONTINUE                                                      TPP1     657
         C    JCONV=8   INSERT BEFORE KEY REQUIREMENT                       TPP1     658
```

TABLE C-1. (Continued)

```
SUBROUTINE INPUT      74/74   OPT=1 TRACE         FTN 4.6+434        06/08/80  15.18.16

      DO 751 I=1,NV
  751 IF (SUMA(I).EQ. 0) K=I
      K1=K-1
      DO 755 I=1,NVV
      DO 755 J=1,K1
  755 IF (SUMA(J).EQ.SUMB(I)) SUMB(I)=0.
      DO 752 I=1,K1
  752 FVALUE(I)=SUMA(I)
      NBB=NVV+K1
      DO 753 I=1,NVV
  753 FVALUE(I+K1)=SUMB(I)
      NVT=NV+NVV
      DO 756 I=1,NBB
      DO 756 J=K,NV
  756 IF (FVALUE(I).EQ.SUMA(J)) SUMA(J)=0.
      DO 754 I=K,NV
  754 FVALUE (I+NVV)=SUMA(I)
      DO 757 I=1,NVT
      IF (FVALUE(I).EQ.0.) GO TO 760
      GO TO 757
  760 DO 761 J=I,NVT
  761 FVALUE(J)=FVALUE(J+1)
  757 CONTINUE
      N=0
      DO 765 I=1,NVT
  765 IF (FVALUE(I).NE.0.) N=N+1
      NV=N
      GO TO 545
  990 CONTINUE
      CALL PRAM (FVALUE,NV,-NBR)
      WRITE (6,886) (FVALUE(I),I=1,NV)
  886 FORMAT (/1X,"CATEGORY RANK",/5X,15(F6.0,2X)/)
      IF (JCONV.EQ.10)GO TO 825
      IF (JCONV.EQ.11) GO TO 850
      IF (JCONV.EQ.12) GO TO 875
      JCONV=9
C
C     RANKED REQUIREMENTS IN RANKED CATEGORIES
      DO 820 I=2,NV
  820 IF (FVALUE(I).LE.0.) GO TO 821
      N=1
      DO 881 I=1,NV
      DO 882 J=1,NBR
      IF (FVALUE(I).NE.ICAT(J)) GO TO 882
      SUMA(N)=FLOAT(IND(J))
      IF (N.GT.NBR) GO TO 882
      N=N+1
  882 CONTINUE
  881 CONTINUE
      DO 883 I=1,NBR
  883 FVALUE(I)=SUMA(I)
      NV=NBR
      GO TO 545
  821 WRITE (6,823)
  823 FORMAT (/" CATEGORIES NOT RANKED,WRONG JCONV"/)
      GO TO 540
  825 CONTINUE
C     JCONV=10
```

TABLE C-1. (Continued)

```
SUBROUTINE INPUT      74/74    OPT=1 TRACE                    FTN 4.6+439        04/09/80  15.39.15

C     RANKED REQUIREMENTS IN UNRANKED CATEGORIES
      DO 940 I=2,NV
  940 IF (FVALUE(I).GT.0.) GO TO 945
      IF (JELE.EQ.1) GO TO 841
      DO 826 I=1,NV
      SUMB(I)=0.
      DO 926 J=1,NBR
      IF (I.EQ.ICAT(J)) SUMB(I)=SUMB(I)+1.
  926 CONTINUE
      GO TO 843
  841 IF=ITT+1
      IL=NBR+ITT
      DO 842 I=1,NV
      SUMB(I)=0.
      DO 842 J=IF,IL
      IF (I.EQ.ICAT(J)) SUMB(I)=SUMB(I)+1.
  842 CONTINUE
  843 CONTINUE
      M=1
      DO 827 I=1,NBR
      SUM=0.
      DO 827 J=1,NV
      SUMA(M)=FLOAT(I)+SUM
      IF (SUMA(M).GT.NBR) GO TO 827
      IF (M.EQ.1) GO TO 829
      MM=M-1
      DO 828 K=1,MM
      IF (ABS(SUMA(M)).EQ.ABS(SUMA(K)).AND.SUM.EQ.0.)  KK=1
  828  IF ( ABS(SUMA(M)).EQ. ABS(SUMA(K))) GO TO 832
      IF (SUM.NE.0.) SUMA(M)=-SUMA(M)
  829 M=M+1
      IF (KK.EQ.1) SUMA(M-1)=ABS(SUMA(M-1))
      KK=0
  832 SUM=SUM+SUMB(J)
  827 CONTINUE
      DO 835 I=1,NBR
  835 FVALUE(I)  =SUMA(I)
      NV=NBR
      GO TO 545
  945 WRITE (6,846)
  846 FORMAT (/" CATEGORIES NOT UNRANKED, WRONG JCONV"/)
      GO TO 540
  85. CONTINUE
C     JCONV=11
C     UNRANKED REQUIREMENTS IN RANKED CATEGORIES
      DO 955 I=2,NV
  955 IF (FVALUE(I).LE.0.) GO TO 856
      M=1
      DO 851 I=1,NV
      DO 851 J=1,NBR
      IF (FVALUE(I).NE.ICAT(J)) GO TO 851
      SUMA(M)=FLOAT(IND(J))
      IF (FVALUE(I).EQ.ICAT(J-1)) SUMA(M)=-SUMA(M)
      IF (M.EQ.NBR) GO TO 891
      M=M+1
  851 CONTINUE
      DO 852 I=1,NBR
```

TABLE C-1. (Continued)

```
        SUBROUTINE INPUT      74/74    OPT=1 TRACE                    FTN 4.6+489         10/08/81  15.38.36

                       552 FVALUE(I)=SUMA(I)                                              TPP1       773
                           NV=NBR                                                         TPP1       774
       638                 GO TO 545                                                      TPP1       775
                       556 WRITE (6,823)                                                  TPP1       776
                           GO TO 548                                                      TPP1       777
                       575 CONTINUE                                                       TPP1       778
                     C     JCONV=12                                                       TPP1       779
       635           C     UNRANKED REQUIREMENTS IN UNRANKED CATEGORIES                   TPP1       780
                           DO 676 I=2,NV                                                  TPP1       781
                       675 IF (FVALUE(I).GT.0.)-GO TO 495                                 TPP1       782
                           DO 677 I=2,NBR                                                 TPP1       783
                       677 IND(I)=-IND(I)                                                 TPP1       784
       643                 DO 678 I=1,NBR                                                 TPP1       785
                       678 FVALUE(I)=FLOAT(IND(I))                                        TPP1       786
                           NV=NBR                                                         TPP1       787
                           GO TO 545                                                      TPP1       788
                       495 WRITE(6,896)                                                   TPP1       789
       645             896 FORMAT (/" CATEGORIES NOT UNRANKED, WRONG JCONV"/)             TPP1       790
                           GO TO 548                                                      TPP1       791
                     C                                                                    TPP1       792
                       777 CONTINUE                                                       TPP1       793
                           RETURN                                                         TPP1       794
       658                 END                                                            TPP1       795


        SYMBOLIC REFERENCE MAP (R=2)

 ENTRY POINTS      DEF LINE      REFERENCES
      1  INPUT          120         649

 VARIABLES    SN  TYPE            RELOCATION
  1133  A          REAL        ARRAY    COATA       REFS       138   DEFINED     155
  2474  C          REAL                             REFS       479     485       515
  2443  EOF      * LOGICAL     *UNDEF               REFS       139
  1742  ERROR      LOGICAL                          REFS       139   DEFINED     142      145      226      211      217
                                                    235        275     287
   144  ESR        REAL        ARRAY    //          REFS       184     376       383   DEFINED      161      377
  2464  FLAG       REAL                             REFS       290     299   DEFINED      295      297
  3157  FVALUE     REAL        ARRAY                REFS       130     263       269      309    2*436      437      439
                                                    446      2*451   2*458       459      461      464    2*473      499
                                                    503        505     509       520      532      535      539      543
                                                    544        552     556       573      617      621      623      637
                                                 DEFINED       439     442       461      463      476      490      493
                                                    506        585     521       524      530      535      543      637
                                                    620        642
     0  HEADER     REAL        ARRAY    100         REFS       142     248   DEFINED      178
  2471  HOLD       REAL                             REFS       444     463   DEFINED      437      455
  2446  I          INTEGER                          REFS       155     365     2*374    2*377      378      393    4*385
                                                    387        391     394       396      397      413    2*429      434
                                                    436        439     448       441      442    2*446      447    4*451
                                                    456        458     461       462      463      464    2*469      465
                                                  4*473      2*485     487     2*488    2*498    2*493      498    2*502
                                                    502        504     509     2*515      510    2*519    2*521    2*524
                                                    520      2*530     532       534      535      544      552      556
```

TABLE C-1. (Continued)

SUBROUTINE INPUT 74/74 OPT=1 TRACE FTN 4.6+452 ??/??/?? 15.10.36

SN	VARIABLES	TYPE		RELOCATION								
					2*563	573	576	3*579	584	3*596	593	2*597
					617	621	623	2*629	637	2*639	2*641	
					DEFINED	154	364	373	375	378	392	391
					357	422	428	433	445	458	455	467
					472	484	486	483	492	494	499	501
					509	514	517	520	523	528	524	531
					539	544	551	554	562	572	575	587
					594	605	616	619	627	634	644	640
455	ICAT	INTEGER	ARRAY	HELP	REFS	133	556	578	586	621	623	
					DEFINED	151	221					
2477	IF	INTEGER			REFS	595	DEFINED	591				
2500	IL	INTEGER			REFS	505	DEFINED	502				
161.	IMAX	INTEGER		HELP	REFS	133	140	283	284	DEFINED	144	
1	IND	INTEGER	ARRAY	HELP	REFS	135	213	232	557	422	539	541
					DEFINED	150	220	639				
2452	INJ	INTEGER			REFS	199	324	DEFINED	188	324		
2462	ISEN	INTEGER			REFS	248	365	374	DEFINED	244		
1037	III	INTEGER		HELP	REFS	133	189	202	238	581	592	
					DEFINED	170	281					
2449	J	INTEGER			REFS	149	150	151	153	155	161	162
					232	233	255	255	269	272	284	285
					297	2*291	297	2*339	329	338	335	335
					343	2*377	2*399	415	417	418	419	2*422
					436	437	438	439	448	454	459	460
					461	462	2*476	488	2*493	2*525	519	2*529
					2*535	556	557	579	596	584	621	622
					623	DEFINED	148	152	162	231	254	268
					291	296	309	324	333	340	376	397
					414	422	435	457	475	487	497	584
					518	527	534	595	577	595	592	620
1133	JCHECK	INTEGER	ARRAY	HELP	REFS	137	277	297	DEFINED	256	286	
2400	JCONV	INTEGER			REFS	1 247	240	281	2*282	2*286	311	312
					2*313	2*317	2*324	325	432	482	546	547
					540	DEFINED	244					
2453	JELE	INTEGER			REFS	188	189	190	231	282	238	427
					574	DEFINED	187					
1743	JERR	LOGICAL			REFS	139	302	DEFINED	143	257	274	281
1022	JMAT	INTEGER		HELP	REFS	133	152	154	DEFINED	143		
25374	JNAME	INTEGER	ARRAY	CDATA	REFS	138	DEFINED	150	385			
2451	JNJ	INTEGER			REFS	100	290	DEFINED	179	298		
24240	JPREF	INTEGER	ARRAY	WORK	REFS	135	291	422	DEFINED	295	297	749
					418	419	421					
24874	JRANK	INTEGER	ARRAY	WORK	REFS	135	291	422	DEFINED	255	284	413
					417							
25786	JSUBL	INTEGER	ARRAY	CDATA	REFS	132	331	335	342	345	354	377
					3*349	391	394	399	415	DEFINED	152	325
					331	336	342	352	354	385	397	359
19	JTIE	INTEGER		100	REFS	132						
2457	JUDGE	INTEGER			REFS	246	248	385	DEFINED	244		
2447	K	INTEGER			REFS	159	199	181	162	199	203	201
					202	203	208	213	3*214	2*220	221	222
					225	224	225	226	279	272	470	287
					349	352	401	416	419	487	489	491
					483	499	516	527	529	539	599	
					DEFINED	157	197	282	269	347	392	398
					419	489	515	597				
2456	KAT	INTEGER			REFS	199	221	DEFINED	197			

TABLE C-1. (Continued)

SUBROUTINE INPUT 74/74 OPT=1 TRACE FTN 4.6+439 04/08/76 15.14.36

VARIABLES SN		TYPE		RELOCATION								
2582	KK	INTEGER			REFS	682	DEFINED	598	633			
2465	K1	INTEGER			REFS	331	334	487	483	516	628	622
					524	DEFINED	329	495	516			
2466	K2	INTEGER			REFS	331	DEFINED	332				
2463	L	INTEGER			REFS	2*271	277	284	2*290	[illegible]	417	
					DEFINED	270	334	416				
2467	M	INTEGER			REFS	337	334	391	396	2*532	434	[illegible]
					447	449	457	469	471	2*474	543	[illegible]
					539	548	557	558	559	593	594	595
					596	598	599	2*600	661	2*622	622	623
					624	625	DEFINED	332	337	343	391	434
					446	447	456	466	469	527	583	537
					539	553	559	589	621	614	625	
8	MAIR	INTEGER		F.P.	REFS	134	166	252	2*318	314	363	341
					DEFINED	165						
2473	MM	INTEGER			REFS	458	472	597	DEFINED	445	471	556
2444	N	INTEGER			REFS	226	229	DEFINED	146	226		
1131	N[illegible]	INTEGER	ARRAY	HELP	REFS	133	199	200	222	223		
					DEFINED	197						
3	NAMS	INTEGER	ARRAY	CDATA	REFS	134	2*216	DEFINED	222	223		
2475	NB3	INTEGER			REFS	496	526	DEFINED	491	522		
1	NBR	INTEGER		CDATA	REFS	131	238	231	256	259	263	271
					296	322	329	333	334	341	347	363
					392	392	393	397	462	464	463	491
					543	555	556	562	564	577	592	593
					596	606	608	621	624	627	624	634
					643	647	DEFINED	189	229	230		
2459	NCOMP	INTEGER			REFS	178	171	323	DEFINED	165	434	
2454	NELE	INTEGER			REFS	192	DEFINED	187				
2745	NEQ	INTEGER			REFS	207	419	DEFINED	141			
13	NFU2	INTEGER		IOO	REFS	132	DEFINED	181	183	252		
2744	NGT	INTEGER			REFS	205	418	DEFINED	141			
1	NJ	INTEGER		CDATA	REFS	132	259	334	385	366	337	339
					2*331	335	338	2*343	349	352	2*354	354
					2*377	378	393	4*325	387	391	334	2*399
					433	415	DEFINED	146	384			
15	NOTCOM	INTEGER		IOO	REFS	132	DEFINED	16	189	311		
14	NPRINT	INTEGER		IOO	REFS	132	166	DEFINED	165			
11	NPTYP1	INTEGER		IOO	REFS	132	166	DEFINED	165			
12	NPTYP2	INTEGER		IOO	REFS	132	166	DEFINED	165			
25541	NSIZE	INTEGER	ARRAY	CDATA	REFS	130	DEFINED	159	326	356	483	
2	NV	INTEGER		HELP	REFS	133	263	264	291	356	346	322
					328	33.	346	348	2*354	363	364	373
					375	376	378	403	412	414	422	427
					428	435	445	457	467	474	475	474
					481	494	496	497	499	514	525	527
					529	543	544	551	554	572	575	583
					592	616	619	637	DEFINED	357	402	474
					518	548	564	680	629	647		
2474	NVT	INTEGER			REFS	501	496	506	531	534	539	
					DEFINED	494	525					
2470	NVV	INTEGER			REFS	351	352	356	357	433	459	449
					486	491	492	494	538	517	[illegible]	523
					525	531	DEFINED	341	346	351	427	
2	NWT	INTEGER		CDATA	REFS	130	166	2*173	174	193	226	251
					DEFINED	165	170					
2	SEN	REAL	ARRAY	/ /	REFS	134	363	365	374	377		

TABLE C-1. (Continued)

```
       SUBROUTINE INPUT      74/74    OPT=1 TRACE               FTN 4.6+439       04/04/78  15.34.34

 VARIABLES       SN  TYPE            RELOCATION
                                                    DEFINED    374
   2472  SHOLD     REAL                               REFS     442      446    DEFINED    434      448
   2521  SUM       REAL                               REFS     593      590      632      624    DEFINED    591      624
  23428  SUMA      REAL         ARRAY     WORK        REFS     135      430      443      447      4.1      46.      462
                                                       469     473      476      481      485      489      433      497
                                                       508     515      519      521      524      535      561      566
                                                     2*598   2*599      688      632      637      623      62.
                                                   DEFINED     424      440      442      446      451      462      464
                                                       462     473      490      529      557      541      632      482
                                                       622     623
   2583  SUMB      REAL         ARRAY                 REFS     131      488      489      493      519      526      572
                                                       586     694    DEFINED    499      519      576      574      584
                                                       596
      ?  THLD      REAL                               REFS     156      166      303    DEFINED    162
   2455  WI        REAL                               REFS     199    2*221      225    DEFINED    197
   2451  WJ        REAL                               REFS     249      251      337    DEFINED    244      251
  24553  XI        REAL         ARRAY     COATA       REFS     133    DEFINED    149      225      226
  25227  XJ        REAL         ARRAY     COATA       REFS     132    DEFINED    153      337
      6  Z         REAL         ARRAY     WORK        REFS     135

 FILE NAMES        MODE
        OUTPUT     FMT                   WRITES        259
        TAPE5      FMT                    READS        165     187      197      244
        TAPE6      FMT                   WRITES        146     171      174      192      194      195      234      224
                                            214        233     242      248      272      272      281      244      313
                                            309        379     418      422      544      555      518      431      444

 EXTERNALS             TYPE   ARGS       REFERENCES
        PS14                   3            263        363     479      493      481      543
        REQUIRE                0            489

 INLINE FUNCTIONS  TYPE   ARGS         DEF LINE  REFERENCES
        ABS        REAL      1  INTRIN          2*598   2*599      682
        FLOAT      REAL      1  INTRIN            276     429      557      593      622      641
        IABS       INTEGER   1  INTRIN            278     335      348      349      354      377      345      416
        MAX0       INTEGER   0  INTRIN            226

 STATEMENT LABELS              DEF LINE  REFERENCES
   2233  1         FMT             260      259
      ?  15                        151      149
      ?  11                        155      152      154
      ?  15                        162      157      160
    227  17                        197      ?
      ?  22                        200      203
    132  25                        213      209
      ?  30                        220      213
    231  46                        227      207      212      218
      ?  50                        229      228
    214  63                        236      231      232
      ?  78                        277      178
      0  128       INACTIVE        238
      ?  432                       188      245      247
    223  508                       243      332      434      425
      ?  582                       256      254
    382  585                       277      391
      ?  528                       284      277
    315  510                       288      280      292
```

TABLE C-1. (Continued)

SUBROUTINE INPUT 74/74 OPT=1 TRACE FTN 4.6+439 04/08/80 15.36.36

STATEMENT LABELS		DEF LINE	REFERENCES						
0	512	297	296						
0	513	336	334						
466	514	339	333	335					
0	515	309	308						
417	516	321	317						
0	518	331	328						
475	519	343	325						
0	520	350	344						
675	525	405	362	371	381				
514	53.	353	347	349					
522	532	355	342						
525	534	361	316						
525	540	359	312	320	322	560	612	63	646
267	545	267	477	511	541	565	609	638	643
0	546	374	373						
0	547	377	375	376					
622	548	388	382	384					
616	549	385	383						
666	55.	400	39.	395	396				
644	551	396	394						
0	552	399	397						
0	553	391	390						
636	554	392	401						
0	555	366	364						
540	556	368	365						
543	557	372	367						
745	600	426	266						
0	601	429	428						
0	602	451	450						
0	603	448	445						
773	605	443	433	435	436				
1040	610	465	455	457	458				
0	611	473	472						
0	612	470	467						
1024	625	455	432						
1070	650	474	452						
0	651	476	475						
1107	700	478	262						
0	701	485	484						
0	702	498	489						
0	703	493	492						
0	704	500	499						
0	705	488	486	487					
0	706	490	496	497					
1224	707	506	501	503					
1219	710	504	502						
0	711	505	504						
0	719	509	508						
1242	750	512	402						
0	751	515	514						
0	752	521	520						
0	753	524	523						
0	754	530	529						
0	755	519	517	518					
0	756	520	526	527					
1353	757	536	531	533					
1344	760	534	532						

TABLE C-1. (Continued)

SUBROUTINE INPUT 74/74 OPT=1 TRACE FTN 4.6+433 04/06/79 15.34.36

STATEMENT LABELS			DEF LINE	REFERENCES			
0	761		535	534			
0	765		539	538			
1713	777		648	190			
1371	800		542	261			
0	801		561	554			
1432	802		563	555	556	558	
0	803		563	562			
2373	805	FMT	545	544			
0	820		553	551			
1450	821		556	552			
2443	823	FMT	567	566	631		
1453	825		569	546			
0	826		579	575	577		
1573	827		605	590	592	594	
0	828		549	537			
1562	829		601	595			
1570	832		604	599			
0	835		607	606			
0	840		573	572			
1502	841		581	574			
0	842		587	563	585		
1525	843		586	580			
1611	845		610	573			
2414	846	FMT	611	614			
1614	850		613	547			
1642	851		626	619	620	621	624
0	852		625	627			
0	855		617	616			
1651	856		631	617			
1663	875		633	548			
0	876		637	636			
0	877		639	639			
0	878		642	640			
1710	895		644	637			
2430	896	FMT	645	644			
2041	900	FMT	191	187			
2047	901	FMT	193	192			
2356	902	FMT	195	194			
2075	904	FMT	198	197	199		
2114	905	FMT	205	204			
2125	907	FMT	210	209			
2141	908	FMT	215	214			
2156	910	FMT	234	233			
1772	912	FMT	167	165			
1775	914	FMT	168	166			
2013	915	FMT	172	171			
2024	918	FMT	175	174			
2314	920	FMT	315	313			
2325	921	FMT	369	366			
2203	930	FMT	245	244			
2215	932	FMT	249	248			
2263	933	FMT	279	278			
2246	934	FMT	273	272			
2305	940	FMT	300	299			
2170	941	FMT	241	240			
2277	942	FMT	292	291			
2364	950	FMT	423	422			

TABLE C-1. (Continued)

```
        SUBROUTINE INPUT      74/74   OPT=1 TRACE                 FTN 4.6+439        04/08/80  15.18.36

 STATEMENT LABELS                DEF LINE   REFERENCES
   2347   951      FMT             411        410
   2341   952      FMT             379        376
      0   1000                     413        412
      0   1013                     424        414
    700   1050                     409        407

 LOOPS  LABEL      INDEX       FROM-TO    LENGTH    PROPERTIES
    11   10          J         148 151       4B     INSTACK
    17   11        * J         152 155     14B                NOT INNER
    26   11          I         154 155       2B     INSTACK
    35   15        * K         157 162      16B                NOT INNER
    45   15          J         160 162       3B     INSTACK
   207   69        * J         231 236      14B                EXT REFS
   243  502          J         254 256       3B     INSTACK
   270  510        * J         266 289      30B                EXT REFS
   324             * J         291 291      10B                EXT REFS
   342  512          J         296 297       4B     INSTACK
   371  515          J         308 309       3B     INSTACK
   442  518          J         328 331       4B     INSTACK
   451  514        * J         333 339      20B                NOT INNER
   453  513        *           334 336       7B     INSTACK     EXITS
   500  530        * K         347 353      17B                NOT INNER
   501  520        * J         348 350       7B     INSTACK     EXITS
   532  555        * I         354 366       6B     INSTACK     EXITS
   530  546          I         373 374       3B     INSTACK
   535  547        * I         375 377      17B                NOT INNER
   544  547          J         376 377       4B     INSTACK
   613  549          I         382 388      18B        OPT
   632  553          I         390 391       3B     INSTACK
   640  550        * I         393 400      23B                NOT INNER
   654  552          J         397 399       3B     INSTACK
   706 1000          I         412 413       2B     INSTACK
   717 1010          J         414 420       7B     INSTACK
   733             * J         422 422      10B                EXT REFS
   751  601          I         428 429       3B     INSTACK
   738  605        * I         433 443      20B                NOT INNER
   766  635          J         435 443       6B     INSTACK
  1004  603          I         445 440       5B     INSTACK
  1016  632          I         450 451       4B     INSTACK
  1025  610        * I         455 465      20B                NOT INNER
  1033  610          J         457 465       6B     INSTACK
  1051  612          I         467 470       5B     INSTACK
  1053  611          I         472 473       4B     INSTACK
  1076  651          J         475 476       3B     INSTACK
  1117  701          I         484 485       4B     INSTACK
  1125  709        * I         486 488      14B                NOT INNER
  1131  705          J         487 488       4B     INSTACK
  1143  702          I         489 490       3B     INSTACK
  1155  703          I         492 493       2B     INSTACK
  1164  706        * I         496 498      16B                NOT INNER
  1172  706          J         497 498       4B     INSTACK
  1207  734          I         499 500       2B     INSTACK
  1213  707        * I         501 506      14B                NOT INNER
  1220  711          J         504 505       3B     INSTACK
  1233  715          I         508 509       4B     INSTACK
  1245  751          I         514 515       4B     INSTACK
  1255  755        * I         517 519      14B                NOT INNER
```

TABLE C-1. (Continued)

```
        SUBROUTINE INPUT       74/74    OPT=1 TRACE                    FTN 4.6+439        04/08/80  15.38.36

LOOPS   LABEL     INDEX      FROM-TO    LENGTH    PROPERTIES
 1261   755         J         518 519      4B      INSTACK
 1273   752         I         520 521      3B      INSTACK
 1305   753         I         523 524      2B      INSTACK
 1313   755       * I         526 528     16B                NOT INNER
 1321   756         J         527 528      4B      INSTACK
 1336   754         I         529 530      2B      INSTACK
 1342   757       * I         531 535     14B                NOT INNER
 1347   761         J         534 535      3B      INSTACK
 1362   765         I         538 539      4B      INSTACK
 1407   820       * I         551 552      5B      INSTACK    EXITS
 1415   801       * I         554 561     22B                NOT INNER
 1423   802         J         555 560     10B        OPT
 1442   803         I         562 563      3B      INSTACK
 1454   840       * I         572 573      5B      INSTACK    EXITS
 1463   826       * I         575 579     17B                NOT INNER
 1471   826         J         577 579      5B      INSTACK
 1506   842       * I         583 587     17B                NOT INNER
 1514   842         J         585 587      5B      INSTACK
 1527   827       * I         590 605     51B                NOT INNER
 1531   827       * J         592 605     45B                NOT INNER
 1541   828       * K         597 599     17B        OPT      EXITS
 1603   835         I         606 607      3B      INSTACK
 1615   855       * I         616 617      5B      INSTACK    EXITS
 1623   851       * I         619 626     24B                NOT INNER
 1631   851         J         620 626     12B        OPT
 1652   852         I         627 628      3B      INSTACK
 1664   876       * I         636 637      5B      INSTACK    EXITS
 1674   877         I         638 639      2B      INSTACK
 1702   878         I         640 641      3B      INSTACK

COMMON BLOCKS   LENGTH
        CDATA    21306
        IOD         14
        HELP       906
        / /      10202
        WORK     10500

STATISTICS
  PROGRAM LENGTH                   3323B      1747
  CM LABELED COMMON LENGTH       77726B     32726
  CM BLANK COMMON LENGTH         23732B     10202
```

TABLE C-1. (Continued)

```
      SUBROUTINE FREQ        74/74    OPT=1 TRACE             FTN 4.6+439        04/04/80  15.38.36

C            COMPUTE FREQUENCY MATRIX FOR EACH SUB-LIST
C
      SUBROUTINE  FREQ
C
      COMMON /CDATA/ NBR ,NJ,NNT, NAME(2,300),A(100,100),WI(300),WJ(101)
     *               , INAME(101),NSIZE(101),JSUBL(100,101)
      COMMON/IOO/HEADER(8),NOTCOM,NPTYP1,NPTYP2,NFU2,NPRINT,JTIE
      COMMON /WORK/X(100,100),SUMA(100),JRANK(100),JPREF(100)
      COMMON/  /MATR,THLD,SEM(100),ESR(100,101)
      DATA NDASH/"------"/
      DATA  NGT/" >"/, NEQ/" ="/
C
      DO 600  K = 1,NJ
      NV = NSIZE(K)
      JUDGE = JNAME(K)
C
      DO 502 J=1,NBR
  502 JRANK(J)  = 0
C
      DO 510 J=1,NV
      I = JSUBL(J,K)
      L = IASS(I)
      JRANK(J) = L
      JPREF(J) = NGT
      IF( I .LT. 0 )  JPREF(J) = NEQ
  510 CONTINUE
      JPREF(1) = "  "
C
C           SUB-LIST FREQUENCY MATRIX
      CALL MATRIX (NBR,NV,JUDGE,JRANK,JPREF,X)
C
C     WEIGHT FREQUENCY MATRIX
      IF (MATR.EQ.0) GO TO 520
C
C     SELF EVALUATION WEIGHTING
      DO 515 I=1,NBR
      DO 515 J=1,NBR
      IF (NNT.EQ.0) X(I,J)=A(I,J)
  515 X(I,J)=X(I,J)*ESR(I,K)
      IF (NPRINT.EQ.2.OR.NPRINT.EQ.4.OR.NPRINT.EQ.5) GO TO 500
      WRITE (6,900) HEADER,JUDGE,(JPREF(J),JRANK(J),J=1,NBR)
  900 FORMAT("1SUB-LIST SELF-EVALUATION FREQUENCY-MATRIX",10X,8A10,//1X,
     *A10,(T12,24(A2,I3)/))
      IF (MATR.EQ.2) WRITE(6,910)
  910 FORMAT (/" REDUCED MATRIX"/)
      WRITE (6,901) (J,J=1,NBR)
  901 FORMAT (/" PROJ",(T7,20I6))
      WRITE (6,902) (NDASH,J=1,NBR)
  902 FORMAT (1X,T7,20A6)
      DO 903 I=1,NBR
  903 WRITE (6,904) I,(X(I,J),J=1,NBR)
  904 FORMAT (1X,I3,(T6,"I ",20F6.2))
  500 CONTINUE
C
C     FUNCTIONAL WEIGHTING
      CALL WEIGHT (NNT,NBR,WI,WJ(K),X,JNAME(K))
C
```

TABLE C-1. (Continued)

```
      SUBROUTINE FREQ       74/74    OPT=1 TRACE                      FTN 4.8+439        84/08/90  15.30.36

              C         SUM SUB-LIST                                                TPP1     853
                     DO 520 J = 1,NBR                                               TPP1     854
                     DO 520 I = 1,NBR                                               TPP1     855
                 520 A(I,J) = A(I,J) + Y(I,J)                                       TPP1     856
              C                                                                     TPP1     857
              C                                                                     TPP1     858
                 500 CONTINUE                                                       TPP1     859
              C                                                                     TPP1     860
                     RETURN                                                         TPP1     861
                     END                                                            TPP1     862
```

```
      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS     DEF LINE     REFERENCES
   1  FREQ           3          66

VARIABLES       SN  TYPE              RELOCATION
 1133  A            REAL       ARRAY     CDATA       REFS        5        61     DEFINED      61
  146  ESR          REAL       ARRAY     / /         REFS        9        39
    0  HEADER       REAL       ARRAY     IOO         REFS        7        41
  311  I            INTEGER                          REFS       22        25        2*38      3*39      2*51      3*61
                                                  DEFINED       21        36        58        60
  310  J            INTEGER                          REFS       18        21        23        24        25        2*38      2*39
                                                     2*41       46        51        3*61   DEFINED      17        29        37
                                                     41         46        48        51        59
25374  JNAME        INTEGER    ARRAY     CDATA       REFS        5        15        56
24246  JFREF        INTEGER    ARRAY     WORK        REFS        8        38        41     DEFINED      24        25        27
24074  JRANK        INTEGER    ARRAY     WORK        REFS        8        38        41     DEFINED      18        23
25706  JSUBL        INTEGER    ARRAY     CDATA       REFS        5        21
   15  JTIE         INTEGER              IOO         REFS        7
  3,7  JUDGE        INTEGER                          REFS       30        41     DEFINED      15
  305  K            INTEGER                          REFS       14        15        21        39        2*56
                                                  DEFINED       13
  312  L            INTEGER                          REFS       23     DEFINED      22
    0  MATR         INTEGER              / /         REFS        9        33        44
    3  NAME         INTEGER    ARRAY     CDATA       REFS        5
    0  NBR          INTEGER              CDATA       REFS        5        17        38        36        37        41        46
                                                     48         50        51        56        59        60
  211  NDASH        INTEGER                          REFS       48     DEFINED      10
  213  NEQ          INTEGER                          REFS       25     DEFINED      11
   13  NFUZ         INTEGER              IOO         REFS        7
  212  NGT          INTEGER                          REFS       24     DEFINED      11
    1  NJ           INTEGER              CDATA       REFS        5        13
   15  NOTCOM       INTEGER              IOO         REFS        7
   14  NPRINT       INTEGER              IOO         REFS        7        3*40
   11  NPTYP1       INTEGER              IOO         REFS        7
   12  NPTYP2       INTEGER              IOO         REFS        7
25541  NSIZE        INTEGER    ARRAY     CDATA       REFS        5        14
  306  NV           INTEGER                          REFS       20        38     DEFINED      14
    2  NWT          INTEGER              CDATA       REFS        5        38        56
    2  SEM          REAL       ARRAY     / /         REFS        9
23420  SUMA         REAL       ARRAY     WORK        REFS        8
    1  THLD         REAL                 / /         REFS        9
```

TABLE C-1. (Continued)

```
          SUBROUTINE FREQ      74/74   OPT=1 TRACE                 FTN 4.6+439      [illegible]  15.34.36

  VARIABLES      SN  TYPE             RELOCATION
  24553  WI          REAL        ARRAY    CDATA        REFS        5        56
  25227  WJ          REAL        ARRAY    CDATA        REFS        5        56
      0  X           REAL        ARRAY    WORK         REFS        9        30        30        39        51        56        61
                                                        DEFINED    30        39

  FILE NAMES        MODE
        TAPE6       FMT                       WRITES        41        44        46        48        51

  EXTERNALS             TYPE    ARGS        REFERENCES
        MATRIX                   6              30
        WEIGHT                   6              56

  INLINE FUNCTIONS   TYPE    ARGS          DEF LINE  REFERENCES
        IABS         INTEGER   1  INTRIN                22

  STATEMENT LABELS                DEF LINE    REFERENCES
    146  500                          53          33        40
      0  502                          19          17
      0  510                          26          20
      4  515                          39          36        37
      0  520                          61          59        60
      0  600                          64          13
    225  900      FMT                 42          41
    253  901      FMT                 47          46
    265  902      FMT                 49          48
      0  903                          51          50
    277  904      FMT                 52          51
    241  910      FMT                 45          44

  LOOPS  LABEL    INDEX     FROM-TO     LENGTH    PROPERTIES
      3  600      * K        13 64       1670                 EXT REFS  NOT INNER
     11  502        J        17 19         20     INSTACK
     22  510        J        20 26         70     INSTACK
     37  515      * I        36 39        210                 NOT INNER
     46  515        J        37 39         60     INSTACK
     70           * J        41 41        100                 EXT REFS
    110           * J        45 46         40                 EXT REFS
    120           * J        48 48         40                 EXT REFS
    126  903      * I        50 51        205                 EXT REFS  NOT INNER
    131           * J        51 51        110                 EXT REFS
    153  520      * J        59 61        140                 NOT INNER
    161  520        I        60 61         30     INSTACK

  COMMON BLOCKS   LENGTH
        CDATA      21306
        IOO           14
        WORK       13533
        //         10202

  STATISTICS
    PROGRAM LENGTH                  313B      203
    CM LABELED COMMON LENGTH      76114B    31026
    CM BLANK COMMON LENGTH        23732B    10202
```

TABLE C-1. (Continued)

```
SUBROUTINE MATRIX     74/74   OPT=1 TRACE                    FTN 4.5+459      04/08/80  15.30.36

C             FREQUENCY MATRIX FOR EACH SUB-LIST
C
      SUBROUTINE MATRIX (NBR,NV,JUDGE,JRANK,JPREF,X)
C
C     NTYPE = 0 TO CONSIDER RANKED VARIABLES ONLY
C           = 1 TO CONSIDER ALL UNRANKED VARIABLES EQUAL.
C     NBR   = TOTAL NUMBER OF VARIABLES IN STUDY.
C     JUDGE = NAME OF SUB-LIST.
C     JRANK = PROJECTS RANKED IN ORDER OF PREFERENCE.
C     JPREF = PREFERENCE OF RANKED PROJECTS ( > , = ).
C     X     = FREQUENCY MATRIX FOR SUB-LIST.
C     NV    = NUMBER OF RANKED VARIABLES IN SUB-LIST.
C
      COMMON/IOO/HEADER(8),NOTCOM,NPTYP1,NPTYP2,NFUZ,NPRINT,JTIE
      DIMENSION X(100,100) , JRANK(100) , JPREF(100)
C
      DIMENSION JR(100), JP(100)
      DATA NGT/" >"/, NEQ/" ="/
      DATA NDASH/"------"/
C     SELECT TYPE OF CALCULATION
      EQVAL=0.5
      ADVAL=1.0
      IF (NPTYP1.EQ.0) GO TO 5
      EQVAL=0.0
      ADVAL=0.0
    5 CONTINUE
C
      NVV = NV
      DO 10 J=1,NVV
      JR(J) = JRANK(J)
   10 JP(J) = JPREF(J)
      DO 12 J = 1,NBR
      DO 12 I = 1,NBR
   12 X(I,J) = 0.0
      NVM1=NVV-1
      DO 60 K=1,NVM1
      I = JR(K)
      XX = 1.0
      IF (JP(K+1).EQ.NEQ) XX=EQVAL
      N = K + 1
      DO 40 M=N,NVV
      J = JR(M)
      X(I,J) = XX
      X(J,I)=ADVAL-XX
      IF( JP(M+1) .NE. NEQ )  XX = 1.0
   40 CONTINUE
   50 CONTINUE
C
      IF (NPTYP1.EQ.1) NFUZ=1
      IF (NPRINT.GE.1.AND.NPRINT.LE.3) GO TO 99
      DO 14 I=1,NBR
      DO 14 J=1,NBR
      IF (NPTYP1.EQ.0.AND.X(I,J).EQ..5) JTIE=1
      IF (NPTYP1.EQ.1.AND.X(I,J).EQ.0.) JTIE=1
   14 CONTINUE
      WRITE(6,902) HEADER, JUDGE, ( JP(J), JR(J), J=1,NVV )
  902 FORMAT("1SUB-LIST FREQUENCY MATRIX",20X,8A10//1X,A10,(T12,24(A2,I3
```

TABLE C-1. (Continued)

```
      SUBROUTINE MATRIX     74/74    OPT=1 TRACE                FTN 4.6+439        10/24/80  15.38.36

                      * 3/))                                                        TPP1     920
                       WRITE(6,984) ( J, J=1,NBR )                                  TPP1     921
     60           904 FORMAT(/" PROJ",( I7,20I6 ) )                                 TPP1     922
                      WRITE(6,985) ( NDASH, J=1,NBR )                               TPP1     923
                  905 FORMAT(1X,I7,20A6)                                            TPP1     924
                C                                                                   TPP1     925
                      DO 70 I=1,NBR                                                 TPP1     926
     65               WRITE(6,986) I, ( X(I,J), J=1, NBR )                          TPP1     927
                  906 FORMAT (1X,I3,(T6,"I ",20F6.1))                               TPP1     928
                   70 CONTINUE                                                      TPP1     929
                C                                                                   TPP1     930
                   99 CONTINUE                                                      TPP1     931
     73               RETURN                                                        TPP1     932
                      END                                                           TPP1     933


          SYMBOLIC REFERENCE MAP (R=2)

 ENTRY POINTS      DEF LINE     REFERENCES
   3  MATRIX           3          76

 VARIABLES     SN  TYPE              RELOCATION
   310  AQVAL      REAL                             REFS      44     DEFINED     22     25
   307  EQVAL      REAL                             REFS      39     DEFINED     21     24
     0  HEADER     REAL        ARRAY     IDO        REFS      14       56
   313  I          INTEGER                          REFS      34       43        44     53     54      2*65
                                                    DEFINED   33       37        51     64
   312  J          INTEGER                          REFS      2*38     2*31      34     43     44      53     54
                                                    2*56      59       65     DEFINED   29     33      42     52
                                                    56        59       61        65
   465  JP         INTEGER     ARRAY                REFS      17       39        45     56  DEFINED    31
     0  JPREF      INTEGER     ARRAY     F.P.       REFS      15       31     DEFINED    3
   321  JR         INTEGER     ARRAY                REFS      17       37        42     56  DEFINED    38
     0  JRANK      INTEGER     ARRAY     F.P.       REFS      15       38     DEFINED    3
    15  JTIE       INTEGER               IDO        REFS      14    DEFINED      53     54
     0  JUDGE      INTEGER               F.P.       REFS      56    DEFINED       3
   315  K          INTEGER                          REFS      37       39        40  DEFINED   36
   320  M          INTEGER                          REFS      42       45     DEFINED   41
   317  N          INTEGER                          REFS      41    DEFINED      40
     0  NBR        INTEGER               F.P.       REFS      32       33        51     52     59      61     64
                                                    65     DEFINED      3
   225  NDASH      INTEGER                          REFS      61    DEFINED      19
   224  NEQ        INTEGER                          REFS      39       45     DEFINED   18
    13  NFUZ       INTEGER               IDO        REFS      14    DEFINED      49
   223  NGT        INTEGER                          DEFINED   19
    10  NOTCON     INTEGER               IDO        REFS      14
    14  NPRINT     INTEGER               IDO        REFS      14       2*58
    11  NPTYP1     INTEGER               IDO        REFS      14       23        49     53     54
    12  NPTYP2     INTEGER               IDO        REFS      14
     0  NV         INTEGER               F.P.       REFS      22    DEFINED       3
   314  NVM1       INTEGER                          REFS      36    DEFINED      35
   311  NVV        INTEGER                          REFS      29       35        41     56  DEFINED    20
     0  X          REAL        ARRAY     F.P.       REFS      15       53        54     65  DEFINED     3     36
                                                    43        44
```

TABLE C-1. (Continued)

```
        SUBROUTINE MATRIX      74/74   OPT=1 TRACE                      FTN 4.6+439        14/08/80  15.38.36

VARIABLES      SN  TYPE               RELOCATION
  316  XX          REAL                             REFS         43        44    DEFINED       34        39        45

FILE NAMES         MODE
        TAPE6      FMT                         WRITES         56         59        61        65

STATEMENT LABELS                  DEF LINE   REFERENCES
   22  5                             26         23
    0  10                            31         29
    0  12                            34         32       33
    0  14                            55         51       52
    0  40                            46         41
    0  60                            47         36
    0  70                            67         64
  217  59                            69         58
  237  902      FMT                  57         56
  255  904      FMT                  60         59
  267  905      FMT                  62         61
  301  906      FMT                  66         65

LOOPS  LABEL    INDEX      FROM-TO      LENGTH    PROPERTIES
   30  10         J         29 31          3B     INSTACK
   35  12       * J         32 34         12B                 NOT INNER
   42  12         I         33 34          2B     INSTACK
   52  60       * K         36 47         33B                 NOT INNER
   57  40         I         41 46         12B       OPT
  113  14       * I         51 55         27B                 NOT INNER
  124  14         J         52 55         13B       OPT
  145           * J         56 56         10B                 EXT REFS
  151           * J         59 59          4B                 EXT REFS
  171           * J         61 61          4B                 EXT REFS
  177  70       * I         64 67         20B                 EXT REFS  NOT INNER
  202           * J         65 65         11B                 EXT REFS

COMMON BLOCKS   LENGTH
       IDD          14

STATISTICS
  PROGRAM LENGTH                    657B      431
  CM LABELED COMMON LENGTH           16B       14
```

TABLE C-1. (Continued)

```
SUBROUTINE WEIGHT     74/74    OPT=1 TRACE                    FTN 4.6+420        06/08/80  15.38.36

C           WEIGHT FREQUENCY MATRIX
C
      SUBROUTINE WEIGHT (NWT,NBR,WI,WJ,X,JNAME)
C
C           NWT = WEIGHTING TYPE
C           NBR = NUMBER OF VARIABLES
C           WI  = ROW WEIGHT
C           WJ  = JUDGE WEIGHT
C           X   = SUB-LIST FREQUENCY MATRIX
C
      COMMON/IOO/HEADER(8),NCTCOM,NPTYP1,NPTYP2,NFU2,NPRINT,JTIE
      DIMENSION  WI(100),          X(100,100)
      DATA NDASH/"-------"/
C
      IF( NWT .LT. 1  .OR.  NWT .GT. 6 )  RETURN
      WJJ = WJ
C
C                MULT-MATRIX BY 4 BEFORE WEIG-TING
      DO 90 I=1,NBR
      DO 90 J=1,NBR
   90 X(I,J)=4.*X(I,J)
C
      GO TO    (100,200,300,400,500,600,700,800 )  NWT
C
  100 DO 120 I = 1,NBR
      WII = WI(I)
      DO 120 J = 1,NBR
  120 X(I,J) = WII * X(I,J)
      GO TO 900
C
  200 DO 220 J = 1,NBR
      DO 220 I = 1,NBR
  220 X(I,J) = WJJ * WI(I) * X(I,J)
      GO TO 900
C
  300 DO 320 I = 1,NBR
      WII = WI(I)
      DO 320 J = 1,NBR
      IF( X(I,J) .LE. 0.0 )  GO TO 320
      X(I,J) = X(I,J) ** WII
  320 CONTINUE
      GO TO 900
C
  400 DO 420 J = 1,NBR
      DO 420 I = 1,NBR
      IF( X(I,J) .LE. 0.0 )  GO TO 420
      X(I,J) = X(I,J) ** ( WI(I) * WJJ )
  420 CONTINUE
      GO TO 900
C
  500 DO 520 J=1,NBR
      DO 520 I = 1,NBR
      IF( X(I,J) .LE. 0.0 )  GO TO 520
      X(I,J) = WI(I) * ( X(I,J) ** WJJ )
  520 CONTINUE
      GO TO 900
C
```

TABLE C-1. (Continued)

```
        SUBROUTINE WEIGHT     74/74    OPT=1 TRACE                    FTN 4.6+439         26/08/80  15.30.36

                 1?. DO 628 J = 1,NSR                                          TPP1      991
                     DO 628 I = 1,NSR                                          TPP1      992
                     IF( X(I,J) .LE. 0.0 )  GO TO 628                          TPP1      993
                     X(I,J) = WJJ * ( X(I,J) ** WI(I) )                        TPP1      994
                 628 CONTINUE                                                  TPP1      995
                     GO TO 982                                                 TPP1      996
               C                                                               TPP1      997
                 700 DO 728 J=1,NSR                                            TPP1      998
                     DO 728 I = 1,NSR                                          TPP1      999
                     IF( X(I,J) .EQ. 0.0 )  GO TO 728                          TPP1     1000
                     X(I,J) = X(I,J) - WI(I) + WJJ                             TPP1     1001
                 728 CONTINUE                                                  TPP1     1002
                     GO TO 982                                                 TPP1     1003
               C                                                               TPP1     1004
                 800 DO 828 J = 1,NSR                                          TPP1     1005
                     DO 828 I   1,NSR                                          TPP1     1006
                     IF( X(I,J) .LE. 0 ) GO TO 828                             TPP1     1007
                     X(I,J) = ALOG( WI(I) * WJJ * X(I,J) )                     TPP1     1008
                 828 CONTINUE                                                  TPP1     1009
               C                                                               TPP1     1010
               C         PRINT WEIGHTED MATRIX                                 TPP1     1011
                 982 CONTINUE                                                  TPP1     1012
                     IF (NPRINT.EQ.2.OR.NPRINT.EQ.4.OR.NPRINT.EQ.5) RETURN     TPP1     1013
                     WRITE (6,902) HEADER,JNAME,(J,J=1,NSR)                    TPP1     1014
                 902 FORMAT(///"1WEIGHTED SUB-LIST FREQUENCY MATRIX",10X,8A10//TPP1     1015
                    *2X,A10,//" PROJ",(T7,20I6))                               TPP1     1016
                     WRITE(6,905) ( NDASH, J=1,NSR )                           TPP1     1017
                 905 FORMAT(1X,T7,22A6)                                        TPP1     1018
                     DO  920 I=1,NSR                                           TPP1     1019
                     WRITE(6,906)  I, ( X(I,J), J=1,NSR )                      TPP1     1020
                 906 FORMAT (1X,I3,(T6,"I ",22F6.1))                           TPP1     1021
                 920 CONTINUE                                                  TPP1     1022
                     RETURN                                                    TPP1     1023
                     END                                                       TPP1     1024


        SYMBOLIC REFERENCE MAP (R=2)

 ENTRY POINTS     DEF LINE     REFERENCES
     3 WEIGHT          3        15         82         93

  VARIABLES     SN  TYPE            RELOCATION
      0 HEADER      REAL        ARRAY     IOO           REFS      11        81
    416 I           INTEGER                             REFS    2*21        22      2*24      3*33       37       39      2*42
                                                          46    3*47        53      3*56        62     3*61       67      3*64
                                                          74    3*75      2*87   DEFINED        19       20       32        36
                                                          49      92        99        66        73       80
    417 J           INTEGER                             REFS    2*21      2*24      2*33        39     2*48       46      2*47
                                                          53    2*54        62      2*61        67     2*68       76      2*75
                                                          91      87   DEFINED        20        27       31       36        44
                                                          91      99        65        72        81       94       97
      0 JNAME       INTEGER                 F.P.        REFS      81   DEFINED         3
     15 JTIC        INTEGER               IOO           REFS      11
      4 NSR         INTEGER                 F.P.        REFS      19        20        25        27       31       37        36
```

TABLE C-1. (Continued)

```
        SUBROUTINE WEIGHT      74/74    OPT=1 TRACE                     FTN 4.6+419        06/04/80  15.38.36

 VARIABLES      SN   TYPE              RELOCATION
                                                    38      44      65      51      52      58      59      65
                                                    65      72      78      41      44      46      47
                                               DEFINED       3
      346  NDASH     INTEGER                       REFS     46   DEFINED    13
       13  NFJZ      INTEGER              IOO      REFS     11
       18  NOTDON    INTEGER              IOO      REFS     11
       14  NPRINT    INTEGER              IOO      REFS     11    3*83
       11  NPTYP1    INTEGER              IOO      REFS     11
       12  NPTYP2    INTEGER              IOO      REFS     11
        6  NWT       INTEGER              F.P.     REFS   2*15      23   DEFINED     7
        0  WI        REAL      ARRAY      F.P.     REFS     12      26      35      47      47      54      61
                                                    68      75   DEFINED     3
      422  WII       REAL                          REFS     28      48   DEFINED    26      37
        5  WJ        REAL                 F.P.     REFS     16   DEFINED     3
      415  WJJ       REAL                          REFS     33      47      54      61      68      75
                                               DEFINED      16
        0  X         REAL      ARRAY      F.P.     REFS     12      21      29      33      35      43      46
                                                    47      53      56      49      61      67      68      74
                                                    75      87   DEFINED     3      21      28      33      65
                                                    47      54      61      64      75

 FILE NAMES        MODE
      TAPE5        FMT                    WRITES    91      94      87

 EXTERNALS         TYPE   ARGS      REFERENCES
      ALOG         REAL     1 LIBRARY    75

 STATEMENT LABELS              DEF LINE   REFERENCES
        0  95                     21         19      22
       52  100                    25         23
        0  122                    28         25      27
       71  200                    31         28
        0  220                    33         31      32
      117  300                    36         23
      124  320                    41         36      38      39
      132  400                    44         28
      147  420                    48         44      45      46
      155  500                    51         23
      171  520                    55         51      52      53
      177  600                    58         23
      214  620                    62         58      59      60
      222  700                    65         23
      234  723                    69         65      66      67
      241  800                    72         23
      255  823                    76         72      73      74
      262  900                    79         29      38      42      49      56      53      73
      357  932       FMT          82         81
      376  909       FMT          85         84
      418  936       FMT          88         87
        0  920                    97         96

 LOOPS   LABEL    INDEX     FROM-TO     LENGTH    PROPERTIES
    22     95      * I       19 21       14B               NOT INNER
    27     98        J       20 21       3B      INSTACK
    53    120      * I       25 28       16B               NOT INNER
    62    220        J       27 28       3B      INSTACK
    72    220      * J       31 33       14B               NOT INNER
```

TABLE C-1. (Continued)

SUBROUTINE WEIGHT 74/74 OPT=1 TRACE FTN 4.6+439 04/08/80 15.35.36

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
100	220	I	32 33	3B	INSTACK
110	320	* I	36 41	21B	EXT REFS NOT INNER
113	320	* J	38 41	14B	EXT REFS
133	420	* J	44 48	21B	EXT REFS NOT INNER
134	420	* I	45 48	16B	EXT REFS
156	520	* J	51 55	20B	EXT REFS NOT INNER
157	520	* I	52 55	15B	EXT REFS
200	620	* J	58 62	21B	EXT REFS NOT INNER
201	620	* I	59 62	16B	EXT REFS
223	720	* J	65 69	16B	NOT INNER
231	720	I	66 69	4B	INSTACK
242	820	* J	72 76	20B	EXT REFS NOT INNER
243	820	* I	73 76	15B	EXT REFS
272		* J	81 81	4B	EXT REFS
302		* J	84 84	4B	EXT REFS
310	920	* I	86 89	20B	EXT REFS NOT INNER
313		* J	87 87	11B	EXT REFS

COMMON BLOCKS	LENGTH
IOO	14

STATISTICS

PROGRAM LENGTH	513B	331
CM LABELED COMMON LENGTH	16B	14

TABLE C-1. (Continued)

```
      SUBROUTINE ORDER      74/74    OPT=1 TRACE                    FTN 4.6+439        04/09/80  15.36.36

C                 PRINT  RANK  ORDER
C
      SUBROUTINE  ORDER( NAME , NBR , SUMA )
      COMMON/RANK/LISTC(100,3),LIST(100),LAB(3)
      COMMON/IOO/HEADER(8),KOTCOM,NPTYP1,NPTYP2,NFUZ,NPRINT,JTIE
C
      DIMENSION  SUMA( 1 )
      DIMENSION  JRANK(100), JPREF(100)
C           SORT SUMA
C
      DO 200 J=1,NBR
      JPREF(J) = " "
  200 JRANK(J) = J
      JPREF(1) = " "
C
      DO 210 J=1,NBR
      DO 210 K=J,NBR
      IF( SUMA(J) .GE. SUMA(K) )  GO TO 210
      TEMP = SUMA(J)
      JP  = JRANK(J)
      SUMA(J) = SUMA(K)
      JRANK(J) = JRANK(K)
      SUMA(K) = TEMP
      JRANK(K) = JP
  210 CONTINUE
C
      IF (NPRINT.EQ.5.AND.NAME.NE."PREF") RETURN
      IF( NAME .EQ. " " ) RETURN
C     STORE FOR CONCORDANCE
      IF (NAME.EQ."FUZZY") LAB(3)=NAME
      IF (JTIE.EQ.1.AND.NAME.EQ."ADJ") LAB(1)=NAME
      IF (JTIE.EQ.0.AND.NAME.EQ."BORDA") LAB(1)=NAME
      DO 215 J=1,NBR
      LIST(J)=JRANK(J)
  215 CONTINUE
      DO 216 J=2,NBR
  216 IF (SUMA(J).EQ.SUMA(J-1)) LIST(J)=-LIST(J)
      DO 217 I=1,NBR
      IF (JTIE.EQ.1.AND.NAME.EQ."BORDA") GO TO 217
      IF (JTIE.EQ.0.AND.NAME.EQ."BORDA") LISTC(I,1)=LIST(I)
      IF (JTIE.EQ.1.AND.NAME.EQ."ADJ") LISTC(I,1)=LIST(I)
      IF (JTIE.EQ.0.AND.NAME.EQ."ADJ") GO TO 217
      IF (NAME.EQ."PREF") LISTC(I,2)=LIST(I)
      IF (NAME.EQ."FUZZY")LISTC(I,3)=LIST(I)
  217 CONTINUE
      IF (NPRINT.EQ.5) RETURN
      DO 220 J=2,NBR
  220 IF( SUMA(J) .EQ. SUMA(J-1) )  JPREF(J) = "="
      IF (NAME.EQ."ADJ") NAME="ADJ BORDA"
      WRITE(6,906)  NAME, ( JPREF(J), JRANK(J), J=1,NBR)
  906 FORMAT(//1XA10, (T12,24(A2,I3)//) )
      WRITE(6,908)
  908 FORMAT(1X)
      IF (NAME.EQ."ADJ BORDA") NAME="ADJ"
C
      RETURN
      END
```

TABLE C-1. (Continued)

```
      SUBROUTINE ORDER      74/74    OPT=1 TRACE                    FTN 4.6+439        04/09/80  15.34.36

         SYMBOLIC REFERENCE MAP (R=2)

  ENTRY POINTS       DEF LINE       REFERENCES
      3  ORDER           3          27          28          46          56

  VARIABLES      SN   TYPE             RELOCATION
      0  HEADER      REAL        ARRAY     IOD          REFS         5
    260  I           INTEGER                            REFS      2*40       2*41       2*43       2*44   DEFINED       39
    254  J           INTEGER                            REFS        12       2*13         17         18        19       20       21
                                                          22      2*34       4*37       3*49       2*53   DEFINED       11       16
                                                          33        36         47         50
    257  JP          INTEGER                            REFS        24    DEFINED         20
    425  JPREF       INTEGER     ARRAY                  REFS         5         50    DEFINED         12        14       48
    251  JRANK       INTEGER     ARRAY                  REFS         4         20         22         34        55
                                                     DEFINED        13         22         24
     15  JTIE        INTEGER               IOD          REFS         5         31         32         34        40       41       42
    255  K           INTEGER                            REFS        16         21         22         23        24
                                                     DEFINED        17
    624  LAB         INTEGER     ARRAY     RANK         REFS         4    DEFINED         30         31        32
    454  LIST        INTEGER     ARRAY     RANK         REFS         5         37         40         41        43       44
                                                     DEFINED        34         37
      0  LISTC       INTEGER     ARRAY     RANK         REFS         4    DEFINED         40         41        43       44
      4  NAME        INTEGER                F.P.        REFS        27         28       2*30       2*31      2*32       39       40
                                                          41        42         43         44         49        52       54
                                                     DEFINED         3         49         54
      3  NBR         INTEGER                F.P.        REFS        11         16         17         33        36       39       42
                                                          52   DEFINED          3
     13  NFUZ        INTEGER               IOD          REFS         5
     10  NOTJON      INTEGER               IOD          REFS         5
     14  NPRINT      INTEGER               IOD          REFS         5         27         46
     11  NPTYP1      INTEGER               IOD          REFS         5
     12  NPTYP2      INTEGER               IOD          REFS         5
      0  SUMA        REAL        ARRAY      F.P.        REFS         7       2*18         19         21      2*37     2*43
                                                     DEFINED         3         21         23
    256  TEMP        REAL                               REFS        23    DEFINED         19

  FILE NAMES         MODE
         TAPE6       FMT                          WRITES        50          52

  STATEMENT LABELS                    DEF LINE   REFERENCES
      0  200                             13         11
     43  212                             25         16          17          18
      0  215                             35         33
      0  216                             37         36
    151  217                             45         35          39          42
      0  220                             46         47
    233  906         FMT                 51         50
    242  908         FMT                 53         52

  LOOPS   LABEL      INDEX       FROM-TO     LENGTH     PROPERTIES
     24   230        J            11 13        38       INSTACK
     27   210        J            16 25       218                      NOT INNER
     36   210        K            17 25        68       INSTACK
    100   215        J            33 35        38       INSTACK
    111   216        J            36 37         9       INSTACK
    137   217        I            38 45       133       OPT
```

TABLE C-1. (Continued)

```
SUBROUTINE ORDER        74/74   OPT=1 TRACE                    FTN 4.6+439        04/08/80  15.38.36

LOOPS  LABEL   INDEX    FROM-TO    LENGTH    PROPERTIES
  162  220     J         47  48       48      INSTACK
  175        * J         50  50      100                EXT REFS

COMMON BLOCKS   LENGTH
       RANK       433
       IOO         14

STATISTICS
  PROGRAM LENGTH             603B     387
  CM LABELED COMMON LENGTH   641B     417
```

TABLE C-1. (Continued)

```
SUBROUTINE PREF       74/74    OPT=1 TRACE                 FTN 4.6+439        04/08/80  15.35.36

C                   COMPUTE PREFERENCE
C
      SUBROUTINE  PREF
C
      COMMCN /CDATA/ NBR ,NJ,NNT, NAME(2,300),A(100,100),NI(300),NJ(101)
     *           , JNAME(101),NSIZE(101),JSUBL(100,151)
      COMMCN/IOD/HEADER(8),NOTCOM,NPTYP1,NPTYP2,NFUZ,NPRINT,JTIE
      COMMON /WORK/X(100,100),SUMA(300),JRANK(100),JPREF(100)
      DIMENSION ZZETA(67),PP(67),NZETA(9)
C
      DATA  NDASH/"-------"/
      DATA PP/1.00,0.000,0.625,0.373,0.000,1.000,0.703,0.469,0.234,
     *0.117,0.000,1.000,0.773,0.539,0.309,0.205,0.120,0.051,0.022,0.000,
     *[illegible]
     *0.017,0.006,0.002,0.000,1.000,0.949,0.059,0.768,0.629,0.520,0.393,
     *0.299,0.200,0.153,0.094,0.063,0.037,0.023,0.011,0.0064,0.0025,
     *0.0013,0.0004,0.0001,0.000,1.000,0.9976, 0.950,0.945,0.892,0.883,
     *0.762,0.611,0.498,0.420,0.320,0.243,0.183,0.138,0.095,0.067,0.045,
     *0.030,0.019,0.012,0.007,0.0042,0.0023,0.0013,0.0006,0.0003,
     *0.0001,0.0001,0.0001,0.0001,0.0000/
      DATA ZZETA/0.000,1.000,0.000,0.500,1.000,0.000,0.200,0.400,0.600,
     *0.000,1.000,0.000,0.125,0.250,0.375,0.500,0.625,0.750,0.875,1.000,
     *0.000,0.072,0.143,0.214,0.286,0.357,0.429,0.500,0.572,0.643,0.715,
     *0.787,0.456,0.929,1.000,0.000,0.050,0.100,0.150,0.200,0.250,0.300,
     *0.350,0.400,0.450,0.500,0.550,0.600,0.650,0.700,0.750,0.800,0.850,
     *0.900,0.950,1.000,[illegible],0.133,0.166,0.200,0.233,
     *0.266,0.300,0.333,0.366,0.400,0.433,0.466,0.500,0.533,0.565,0.600,
     *0.633,0.666,0.700,0.733,0.766,0.800,0.833,0.866,0.900,0.933,0.966,
     *1.000/
      DATA NZETA/0,0,1,3,6,12,21,36,57/
C     SELECT TYPE OF CALCULATION
      EQVAL=0.5
      LTVAL=0.0
      ADVAL=1.0
      IF (NPTYP2.EQ.0) GO TO 93
      EQVAL=0.0
      LTVAL=-1.0
      ADVAL=0.0
   93 CONTINUE
C
      CO 130 J=1,NBR
C
      DO 120 I=J,NBR
      XIJ = A(I,J)
      XJI = A(J,I)
      X(I,J) = 0.0
      IF( I .EQ. J )  GO TO 120
      IF( XIJ .NE. XJI )  GO TO 110
      IF (XIJ.EQ.0.0 .AND.NPTYP1.EQ.0) GO TO 120
      X(I,J)=EQVAL
      X(J,I)=EQVAL
      GO TO 120
  110 V = 1.0
      IF (XIJ.LT.XJI) V=LTVAL
      X(I,J) = V
      X(J,I)=ADVAL-V
  120 CONTINUE
```

TABLE C-1. (Continued)

```
SUBROUTINE PREF        74/74    OPT=1 TRACE                    FTN 4.6+439        04/30/80  15.10.36

      130 CONTINUE
C              SUM A(I)
          DO 150 I=1,NBR
          SUMR = 0.0
          DO 140 J=1,NBR
      140 SUMR = SUMR + X(I,J)
      15  SUMA(I) = SUMR
C
          IF (NPRINT.EQ.5) GO TO 170
          WRITE(6,902)  HEADER, ( J, J=1,NBR )
      902 FORMAT ("1COMPUTED PREFERENCE MATRIX",2.X,8A10//"  SUM",(T13,19I6)
         *)
          WRITE(6,905) ( NDASH, J=1,NBR )
      905 FORMAT (1X,(T1-,19A6))
          DO 16. I=1,NBR
      160 WRITE(6,904)  SUMA(I), I, ( X(I,J), J=1,NBR )
      904 FORMAT (1X,F6.1,I4,(T13,"I ",19F6.1))
      170 CONTINUE
C
          CALL  ORDER( "PREF      ", NBR , SUMA )
          IF (NPRINT.EQ.5) RETURN
          IF (NPTYP2.EQ.3) GO TO 220
C              TEMP          1 , 0 , -1
          XNM1 = NBR - 1
          DO 210 J=1,NBR
      21  SUMA(J) = 0.5 * ( SUMA(J) + XNM1 )
      220 CONTINUE
C
C              PROCEDURE FOR  ZETA
C
C
          XX = NBR*(NBR-1)*(NBR+NBR-1)/12.0
          XX = NBR*(NBR-1)*(NBR-2)/6.0
          ZZ = 24.0 / ( NBR*NBR*NBP - NBR*( 4-3*MOD(NBR,2) ) )
C              FIND NUMBER OF FRACTIONAL SUMS
          NF = 0
          DO 230 J = 1,NBR
          SA = JA = SUMA(J)
      230 IF( SA .NE. SUMA(J) )  NF = NF + 1
          IF( MOD( NF,2 ) .NE. 0 )  WRITE(6,919)  NF
      919 FORMAT (/"****ERROR**NUMBER OF FRACTIONAL SUMS =",I3/)
          WRITE (6,950) NF
      95  FORMAT (1X,"NUMBER OF FRACTIONAL SUMS=",I5)
          LE = 3
          IF( NF .EQ. 0 )  LE = 1
          OS = 3
          NR = 1
          NRC = 0
C
          DO 310 L = 1,LE
          IF( L .EQ. 3 )  GO TO 305
          JSUM = 0
          I    = 0
          NH=2
          DO 300 J = 1,NBR
          SA = JA = SUMA(J)
          IF( SA .EQ. SUMA(J) )  GO TO 300
C              FRACTION
```

TABLE C-1. (Continued)

```
SUBROUTINE PREF        74/74   OPT=1 TRACE                    FTN 4.6+439        06/08/80  15.30.36

      I = I + 1
      IF (I.EQ.NH) NR=NRC
      IF (I.EQ.NH) NH=NH+2
      JA = JA + NR
C 303 JSUM = JSUM + JA*JA
      NR=1
      IF (L.EQ.2) NR=0
      JA=JA
  309 JSUM = JSUM + JA*(JA-1)
C
      D     = XX - JSUM/2.0
      IF (D.LT.0.) WRITE (6,906)
  906 FORMAT (T130,"-")
      IF (D.LT.0.) D=0.
  3:5 ZETA = 1.0 - D * ZZ
C
C         TEST ZETA
C
      IF (NBR.GT.9) GO TO 25
      NSTART=NZETA(NBR)
   10 CONTINUE
      IF (ZETA.EQ.ZZETA(NSTART)) GO TO 30
      IF(ZETA.LT.ZZETA(NSTART+1).AND.ZETA.GT.ZZETA(NSTART)) GO TO 20
      NSTART=NSTART+1
      GO TC 10
C          INTERPOLATION
   20 CONTINUE
      P=PP(NSTART+1)+(PP(NSTART)-PP(NSTART+1))*(ZETA-ZZETA(NSTART+1))/
     *(ZZETA(NSTART)-ZZETA(NSTART+1))
      GO TC 40
   30 P=PP(NSTART)
      GO TO 40
   25 CONTINUE
      GNU=(NBR*(NBR-1)*(NBR-2))/((NBR-4)**2)
      CS=(8./(NBR-4.))*(.25*(NBR*(NBR-1)*(NBR-2)/6.)-D+.5)+GNU
      PRINT 1, CS,GNU
    1 FORMAT (/1X,"CHI-SQUARE =",F10.3,5X,"DF ="F10.3)
      CALL MDCH (CS,GNU,P,IER)
      P=1.-P
   40 CONTINUE
      IF(  L .EQ. 1 )  LAB = "LOWER"
      IF(  L .EQ. 2 )  LAB = "UPPER"
      IF(  L .EQ. 3 )  LAB = "AVERAGE"
      IF(  LL .EQ. 1 )  LAB = " "
      IF (D.LT.0.) WRITE(6,930) LAB   ,D,LAB
  930 FORMAT (/1X,"KENDALL D BRACKET",A10," D= ",F6.2,"THEREFORE ",A10,
     *"WILL BE ZERO")
      WRITE(6,900)  LAB, NBR, D, ZETA, P
  900 FORMAT (/1X,A10," N= ",I3,5X,"KENDALL D = ",F10.2,4X,"ZETA = ",
     *F10.4,5X,"PROB THAT RANK ORDER NOT CONSISTANT = ",F10.0/)
      PTEST=.05
      DO 320 J=1,2
      KNOT="   "
      IF (P.GE.PTEST) KNOT="NOT"
      WRITE (5,920)KNOT,PTEST
      PTEST=.01
  320 CONTINUE
```

TABLE C-1. (Continued)

```
      SUBROUTINE PREF        74/74    OPT=1 TRACE                    FTN 4.6+439       ??/??/?? 15.14.36

                         32  FORMAT (1X,"RANK ORDER ",A3," CONSISTANT AT",F4.2," LEVEL")        TPP1    1253
                             NR=0                                                                TPP1    1254
                             NRC = 1                                                             TPP1    1255
         175                 DS = DS + D                                                         TPP1    1256
                             D = DS / 2.0                                                        TPP1    1257
                        310  CONTINUE                                                            TPP1    1258
                      C                                                                          TPP1    1259
                      C                                                                          TPP1    1260
       183                   RETURN                                                              TPP1    1261
                             END                                                                 TPP1    1262


      SYMBOLIC REFERENCE MAP (R=2)

 ENTRY POINTS     DEF LINE     REFERENCES
     1  PREF          3          78       180

 VARIABLES       SN  TYPE          RELOCATION
   2133  A            REAL         ARRAY   CDATA     REFS       5        44        45
    643  ADVAL        REAL                           REFS      26   DEFINED        34        38
    674  CS           REAL                           REFS     150       152   DEFINED       149
    667  D            REAL                           REFS     126       128       129       149     2*159       162       175
                                                  DEFINED     125       120       176
    661  DS           REAL                           REFS     175       176   DEFINED       102       175
    641  EQVAL        REAL                           REFS      50        51   DEFINED        32        36
    673  GNU          REAL                           REFS     149       150       152   DEFINED       149
      0  HEADER       REAL         ARRAY   IOD       REFS       7        67
    645  I            INTEGER                        REFS      44        45        46        47        50        51        55
                                                           56        63        64      3*73       115       116       117
                                                  DEFINED      43        60        72       123       115
    675  IER       *  INTEGER                        REFS     152
    644  J            INTEGER                        REFS      43        44        45        46        47        50        51
                                                           55        56        63        67        73      2*43        94        95
                                                          112       113   DEFINED        41        62        67        78        73
                                                           92        93       111       166
    637  JA           INTEGER                        REFS     118       122     2*123   DEFINED        94       112       118
  25374  JNAME        INTEGER      ARRAY   CDATA     REFS       5
  24240  JPREF        INTEGER      ARRAY   WORK      REFS       6
  24874  JRANK        INTEGER      ARRAY   WORK      REFS       6
  25706  JSUBL        INTEGER      ARRAY   CDATA     REFS       5
    665  JSUM         INTEGER                        REFS     123       125   DEFINED       108       123
     15  JTIE         INTEGER              IOD       REFS       7
    780  KNOT         INTEGER                        REFS     169   DEFINED       167       160
    664  L            INTEGER                        REFS     107       121       155       156       157
                                                  DEFINED     106
    676  LAB          INTEGER                        REFS   2*159       162   DEFINED       155       156       157       158
    000  LC           INTEGER                        REFS     100       150   DEFINED       100       101
    642  LTVAL        INTEGER                        REFS      54   DEFINED        33        37
      3  NAME         INTEGER      ARRAY   CDATA     REFS       5
      0  NBR          INTEGER              CDATA     REFS       5        41        43        50        62        67        70
                                                           72        73        77        81        82      3*89      5*90        93
                                                          111       133       134     4*148     4*149       162
    427  NDASH        INTEGER                        REFS      74   DEFINED        11
    655  NF           INTEGER                        REFS      95      2*96        98       101   DEFINED        92        95
```

TABLE C-1. (Continued)

```
        SUBROUTINE PREF        74/74    OPT=1 TRACE                    FTN 4.6+439        06/05/80  15.39.36

 VARIABLES      SN  TYPE            RELOCATION
      13  NFUZ      INTEGER               IDO        REFS        7
     666  NN        INTEGER                          REFS      116     2*117   DEFINED      110       117
       1  NJ        INTEGER               CDATA      REFS        5
      10  NOTCON    INTEGER               IDO        REFS        7
      14  NPRINT    INTEGER               IDO        REFS        7        66        78
      11  NPTYP1    INTEGER               IDO        REFS        7        49
      12  NPTYP2    INTEGER               IDO        REFS        7        35        79
     662  NR        INTEGER                          REFS      110   DEFINED       103       116       129       131       173
     663  NRC       INTEGER                          REFS      116   DEFINED       104       174
   25941  NSIZE     INTEGER     ARRAY     CDATA      REFS        5
     671  NSTART    INTEGER                          REFS      136     2*137       138     6*142       145
                                                  DEFINED      134       130
       2  NNT       INTEGER               CDATA      REFS        5
    1157  NZETA     INTEGER     ARRAY                REFS        9       134   DEFINED        30
     672  P         REAL                             REFS      152       153       162       169   DEFINED       142       145
                                                      153
    1038  PP        REAL        ARRAY                REFS        9     3*142       145   DEFINED        12
     677  PTEST     REAL                             REFS      160       169   DEFINED       165       170
     656  SA        REAL                             REFS       95       113   DEFINED        94       112       122
   23420  SUMX      REAL        ARRAY     WORK       REFS        6        73        77        93        94        95       112
                                                      113  DEFINED        64        83
     651  SUMR      REAL                             REFS       63        64   DEFINED        61        63
     650  V         REAL                             REFS       55        56   DEFINED        53        54
   24553  WI        REAL        ARRAY     CDATA      REFS        5
   25227  WJ        REAL        ARRAY     CDATA      REFS        5
       0  X         REAL        ARRAY     WORK       REFS        9        63        73   DEFINED        46        50        51
                                                       55        56
     646  XIJ       REAL                             REFS       48        49        54   DEFINED        44
     647  XJI       REAL                             REFS       49        54   DEFINED        45
     652  XNMI      REAL                             REFS       83   DEFINED        81
     653  XX        REAL                             REFS      125   DEFINED        89
     670  ZETA      REAL                             REFS      136     2*137       142       162   DEFINED       129
     654  ZZ        REAL                             REFS      129   DEFINED        98
     701  ZZETA     REAL        ARRAY                REFS        9       136     2*137     3*142   DEFINED        21

 FILE NAMES       MODE
         OUTPUT   FMT                     WRITES      150
         TAPE6    FMT                     WRITES       67        70        73        96        99       126       159       162
                                            169

    EXTERNALS          TYPE   ARGS        REFERENCES
         NOCM                   4           152
         ORDER                  2            77

    INLINE FUNCTIONS   TYPE   ARGS        DEF LINE  REFERENCES
         MOD           INTEGER  2  INTRIN             50        96

    STATEMENT LABELS               DEF LINE   REFERENCES
     532  1        FMT              151        158
     274  10                        139        139
     303  20                        141        137
     315  25                        147        133
     312  30                        145        136
     341  40                        154        144       148
      11  90                         39         35
      38  110                        93         40
      46  120                        57         43        47        49        52
```

TABLE C-1. (Continued)

```
        SUBROUTINE PREF        74/74    OPT=1 TRACE                    FTN 4.6+439        04/28/80  15.38.36

  STATEMENT LABELS              DEF LINE   REFERENCES
       0  130                        58        41
       0  140                        63        62
       0  150                        64        60
       0  160                        73        72
     140  170                        75        66
       0  210                        83        82
     157  220                        84        79
       0  230                        95        93
     257  300                       123       111      113
     266  305                       129       107
       0  310                       177       106
       0  320                       171       166
     437  902       FMT              68        67
     470  904       FMT              74        73
     455  905       FMT              71        70
     522  906       FMT             127       126
     557  908       FMT             163       162
     536  916       FMT              97        96
     611  920       FMT             172       169
     546  930       FMT             160       159
     512  950       FMT              99        98

    LOOPS  LABEL    INDEX       FROM-TO     LENGTH    PROPERTIES
       12  130     * J          41 58        41B               NOT INNER
       24  120       I          43 57        24B        OPT
       54  150     * I          60 64        16B               NOT INNER
       62  140       J          62 63         3B      INSTACK
       77          * J          67 67         4B               EXT REFS
      107          * J          70 70         4B               EXT REFS
      115  160     * I          72 73        23B               EXT REFS  NOT INNER
      123          * J          73 73        11B               EXT REFS
      152  210       J          82 83         4B      INSTACK
      175  230       J          93 95         6B      INSTACK
      220  310     * L         106 177      174B               EXT REFS  NOT INNER
      231  300       J         111 123       24B        OPT
      371  320     * J         166 171       13B               EXT REFS

  COMMON BLOCKS   LENGTH
        CDATA      21306
        IOD           14
        WORK       10500

    STATISTICS
      PROGRAM LENGTH              1172B      634
      CM LABELED COMMON LENGTH   76114B    31820
```

TABLE C-1. (Continued)

```
SUBROUTINE FUZZY       74/74   OPT=1 TRACE                    FTN 4.8+439        86/08/80  15.18.35

      C       FUZZY RANK ORDER
      C
              SUBROUTINE FUZZY
      C
              COMMON /CDATA/ NBR ,NJ,NMT, NAME(2,300),A(100,100),NI(300),NJ(101)
             *       , JNAME(101),NSIZE(101),JSUML(100,101)
              COMMON/IOO/HEADER(8),NCTCOM,NPTYP1,NPTYP2,NFUZ,NPRINT,JTIE
              COMMON /WORK/X(100,100),SUMA(300),JRANK(100),JPREF(100)
              DATA  NDASH/"-------"/
      C
      C       DIVIDE EACH A(I,J) BY NUMBER OF JUDGES
              XNJ = NJ
              DO 110 J=1,NBR
              DO 110 I=1,NBR
        11    A(I,J)   A(I,J) / XNJ
      C
              WRITE(6,922) HEADER,  (J, J=1,NBR )
          922 FORMAT ("1NORMALIZED FREQUENCY MATRIX-FUZZY",14X,8A10//(T6,20I6))
              WRITE(6,904)  ( NDASH, J=1,438 )
          904 FORMAT(T6,20A6)
              DO 120 I=1,NBR
          120 WRITE(6,906)  I, ( A(I,J), J=1,NBR )
          906 FORMAT (1X,I3,(T6,"I ",20F6.1))
      C
      C
              TRACE F = 0.0
              TRACE C = 0.0
              DO 200 I = 1,NBR
              DO 200 J = 1,NBR
              TRACE F = TRACE F  + A(I,J) * A(J,I)
              TRACE C = TRACE C  + A(I,J) * A(I,J)
          200 CONTINUE
      C       COMPUTE  F(R)
              FR = 2.0 * TRACE F / ( NBR*NBR - NBR )
      C       COMPUTE C(R)
              CR = 2.0 * TRACE C / ( NBR*NBR - NBR )
      C
              WRITE(6,912)  FR
              WRITE(6,914)  CR
          912 FORMAT(/" F(R) ="F7.3)
          914 FORMAT(/" C(R) =",F7.3)
      C
              DO 310 J = 1,NBR
              XX = 0.0
              DO 300 I = 1,NBR
              XX = AMAX1( XX , A(I,J)-A(J,I) )
          300 CONTINUE
              SUMA(J) = 1.0 - XX
          310 CONTINUE
      C
              WRITE(6,916)  (     J  , J=1,NBR )
              WRITE(6,918)  ( SUMA(J) , J=1,NBR )
          916 FORMAT(/// 1X,"PROJECT",(T12,20I5) )
          918 FORMAT(1X,"FUZZY RANK" ,(T14,20F5.2) )
      C
              CALL  ORDER( "FUZZY     " , NBR , SUMA )
      C
```

TABLE C-1. (Continued)

```
      SUBROUTINE FUZZY      74/74   OPT=1 TRACE                    FTN 4.6+439       04/09/80  15.38.36

               C                                                            TPP1      1320
                           RETURN                                           TPP1      1321
    60                     END                                              TPP1      1322


      SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE      REFERENCES
    1  FUZZY          3            59

VARIABLES     SN   TYPE            RELOCATION
  1133  A          REAL       ARRAY    CDATA     REFS       5       15       22      2*32     2*31     2*46
                                                 DEFINED   15
   274  CP         REAL                          REFS      33    DEFINED     36
   273  FR         REAL                          REFS      38    DEFINED     34
     0  HEADER     REAL       ARRAY    IDO       REFS       7       17
   270  I          INTEGER                       REFS     2*15     2*22     2*30     2*31     2*46
                                                 DEFINED   14       21       28       45
   267  J          INTEGER                       REFS     2*15      17       22      2*33     2*31     2*46     46
                                                   51      52    DEFINED     13       17       15       22       29
                                                   43      51       52
 25374  JNAME      INTEGER    ARRAY    CDATA     REFS       5
 24640  JPREF      INTEGER    ARRAY    WORK      REFS       4
 24874  JRANK      INTEGER    ARRAY    WORK      REFS       8
 25706  JSUBL      INTEGER    ARRAY    CDATA     REFS       5
    15  JTIE       INTEGER             IDO       REFS       7
     9  NAME       INTEGER    ARRAY    CDATA     REFS       5
     6  NBR        INTEGER             CDATA     REFS       5       13       14       17       15       21       22
                                                   20      29     3*34     3*36      43       45       51       52
                                                   56
   102  NDASH      INTEGER                       REFS      19    DEFINED      9
    13  NFUZ       INTEGER             IDO       REFS       7
     1  NJ         INTEGER             CDATA     REFS       5       12
    18  NOTCON     INTEGER             IDO       REFS       7
    14  NPRINT     INTEGER             IDO       REFS       7
    11  NPTYP1     INTEGER             IDO       REFS       7
    12  NPTYP2     INTEGER             IDO       REFS       7
 25541  NSIZE      INTEGER    ARRAY    CDATA     REFS       5
     2  NNT        INTEGER             CDATA     REFS       5
 23428  SUMA       REAL       ARRAY    WORK      REFS       8       52       56    DEFINED     48
   272  TRACEO     REAL                          REFS      31       36    DEFINED     27       31
   271  TRACEF     REAL                          REFS      38       34    DEFINED     26       38
 24553  WI         REAL       ARRAY    CDATA     REFS       5
 25227  WJ         REAL       ARRAY    CDATA     REFS       5
     0  X          REAL       ARRAY    WORK      REFS       4
   266  XNJ        REAL                          REFS      15    DEFINED     12
   275  XX         REAL                          REFS      46       40    DEFINED     44       46

FILE NAMES         MODE
      TAPE5        FMT                WRITES       17      19       22       38       39       51       52

EXTERNALS          TYPE   ARGS     REFERENCES
      ORDER                 3          56
```

TABLE C-1. (Continued)

```
      SUBROUTINE FUZZY       74/74    OPT=1 TRACE                    FTN 4.6+439         04/09/80  15.38.36

INLINE FUNCTIONS   TYPE    ARGS          DEF LINE  REFERENCES
      AMAX1      REAL       0  INTRIN                  46

STATEMENT LABELS             DEF LINE    REFERENCES
    0  11.                       15         13         14
    0  120                       22         21
    0  280                       32         26         29
    0  300                       47         45
    0  31.                       49         43
  172  902       FMT             16         17
  207  904       FMT             20         19
  220  906       FMT             23         22
  234  912       FMT             40         38
  237  914       FMT             41         39
  254  916       FMT             53         51
  260  918       FMT             54         52

LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
    5  11.     * J           13 15        13B              NOT INNER
   12  110       I           14 15        3B        INSTACK
   23          * J           17 17        4B               EXT REFS
   33          * J           19 19        4B               EXT REFS
   42  12.     * I           21 22        21B              EXT REFS  NOT INNER
   44          * J           22 22        11B              EXT REFS
   63  280     * I           28 32        20B              NOT INNER
   72  280       J           29 32        5B        INSTACK
  114  31.     * J           43 49        22B              NOT INNER
  124  300       I           45 47        5B        INSTACK
  141          * J           51 51        4B               EXT REFS

COMMON BLOCKS   LENGTH
      CDATA      2136
      IDD          14
      WORK      10500

STATISTICS
  PROGRAM LENGTH               300B      192
  CM LABELED COMMON LENGTH   76114B    31820
```

TABLE C-1. (Continued)

```
      SUBROUTINE CONCOR        74/74    OPT=1 TRACE                     FTN 4.6+479         08/28/80  15.38.36

      SUBROUTINE CONCOR
C
      COMMON /CODE1/ NBR ,NJ,NWT, NAME(2,333),A(100,100),W1(300),NJ(101)
     *             , JNAME(2,3),NSIZE(101),JSUBL(100,101)
C
      COMMON/IOO/HEADER(8),NOTCOM,NPTYP1,NPTYP2,NFUZ,NPRINT,JTIE
      REAL  XSUBL(100,101)
      EQUIVALENCE ( XSUBL,JSUBL )
C
      DIMENSION  P(101), JTEMP(100)
      DIMENSION CCM(23,7,2)
      DATA  NDASH/"-------"/
      DATA (CCM(J,3,1),J=1,23)/8.,7.4,19.,25.,31.,39.,43.,48.1,54.,63.,
     *66.,71.9,77.0,83.0,89.4,95.4,102.,107.7,113.7,119.7/
      DATA(CCM(J,4,1),J=1,23)/8.,18.5,35.,49.5,62.6,75.7,89.7,101.7,
     *114.8
     *,127.4,140.4,153.4,166.9,173.9,192.5,205.9,219.9,232.,245.,259./
      DATA (CCM(J,5,1),J=1,23)/3.,37.,64.4,88.,112.3,136.1,159.9,183.7,
     *207.4,231.2,254.9,278.6,302.4,326.1,3 9.8,373.5,397.3,421.,444.8,
     *468.5/
      DATA (CCM(J,6,1),J=1,23)/3., 54.,103.9,143.3,182.4,221.4,260.2,
     *299.,
     *337.8,376.7,415.5,454.2,493.,531.7,570.5,609.3,648.1,686.8,725.6,
     *764.4/
      DATA (CCM(J,7,1),J=1,23)/8., 97.,157.3,217.,276.7,335.2,394.2,
     *453.1,
     *512.,571.,629.8,688.6,747.3,836.1,864.9,923.7,982.4,1041.2,1099.9,
     *1158.7/
      DATA (CCM(J,3,2),J=1,23)/3.,7.3,19.,31.,41.,52.,59.4,66.0,75.9,
     *85.1,94.3,103.5,112.7,121.9,131.,140.2,149.4,158.6,167.8,177./
      DATA (CCM(J,4,2),J=1,23)/8.,19.,42.,61.4,80.5,99.5,118.4,137.4,
     *156.4,175.3,194.2,213.1,232.,250.9,269.8,288.7,307.6,326.4,345.3,
     *364.2/
      DATA (CCM(J,5,2),J=1,23 /[illegible]
     *242.7,
     *275.9,339.1,342.3,375.5,430.7,441.9,475.[illegible],541.6,574.8,608.,
     *641.2/
      DATA (CCM(J,6,2),J=1,2[illegible]
     *[illegible]
     *[illegible]
     *1022.2/
      DATA (CCM(J,7,2),J=1,2[illegible]
     *579.9,
     *650.4,737.[illegible],1051.[illegible],1129.5,1200.[illegible]
     *1463.4,1521.9/
C
C        NJ = NUMBER OF JUDGES
      M = NJ
C         NBR = NUMBER OF PROJECTS
      N = NBR
      NSUMT = 0
C             GENERATE EVALUATION TABLE
      DO 90 J = 1,M
C        SIZE OF SUB-LIST
      L = NSIZE(J)
C            STORE SUB-LIST
      DO 30 K = 1,L
```

TABLE C-1. (Continued)

```
SUBROUTINE CONCOR     74/74    OPT=1 TRACE                    FTN 4.6+439       04/08/80  15.30.36

   30 JTEMP(K) = JSUBL(K,J)
      XX = N - L + 1
      XX = XX / 2.0
C                 COMPLETE SUB-LIST TABLE
      IF( L .EQ. N )  GO TO 45
      I = N - L
      NSUMT = NSUMT + I*I*I - I
      DO 40 K = 1,N
   40 XSUBL(K,J) = XX
C
C                 ASSUME NO MATCHES
   45 DO 50 K = 1,L
      JAV = IABS( JTEMP(K) )
      XX = K
   50 XSUBL(JAV,J) = XX
C                 FIND MATCHES
      NEG = 0
      DO 90 K = 2,L
      JV = JTEMP(K)
      IF( JV .GT. 0 )  GO TO 80
      NEG = NEG + 1
      J2 = K
      IF( K .NE. L )  GO TO 90
   80 IF( NEG .LE. 0 )  GO TO 90
      J1 = J2 - NEG
      XX = J1 + J2
      XX = XX / 2.0
C                 INSERT MATCHES
      DO 70 I = J1,J2
      JAV = IABS( JTEMP(I) )
   70 XSUBL(JAV,J) = XX
      I = NEG + 1
      NSUMT = NSUMT + I*I*I - I
      NEG = 0
   93 CONTINUE
   33 CONTINUE
C
      SUMT = NSUMT
      SUMT = SUMT / 12.0
C
      WRITE(6,902)   EADER, ( J, J=1,N )
  902 FORMAT ("1CONCORDANCE SUMMARY BY ELEMENT" 20X,8A10/" UNWEIGHTED SJ
     *BLISTS"/(T12,20I6))
      WRITE(6,904)  ( NDASH, K=1,N )
  904 FORMAT(" JUDGE  ", (T13,20A6) )
C
      DO 100 K=1,N
  100 R(K) = 0.0
      SUMR = 0.0
C
      DO 110 J=1,N
      IF (JNAME(J).EQ."ADJ") JNAME(J)="ADJ BORDA"
      WRITE(6,906)  JNAME(J), (XSUBL(K,J), K=1,N)
  906 FORMAT (1X A10,(T13,"I ",20F6.1))
      DO 110 K=1,N
      R(K) = R(K) + XSUBL(K,J)
```

TABLE C-1. (Continued)

```
SUBROUTINE CONCOR      74/74    OPT=1 TRACE                    FTN 4.6+439          06/09/50  15.14.36

      SUMR = SUMR + XSUBL(    )
  114 CONTINUE
C
      RBAR = SUMR / N
      WRITE(6,908) NCASH, ( ND SM, K=1,N )
  908 FORMAT(T6,A6, (T13,20A6) )
      WRITE(6,910)  ( R(K), K=1,N )
  910 FORMAT(" R(    ,T14,20 F6.1) )
C
      S = 0.0
      DO 120 K=1,N
  120 S = S + ( R(K) - RBAR )**2
      WRITE(6,912)  RBAR, S
  912 FORMAT (/" MEAN =",F10.2,5X,"SUM OF DEVIATIONS SQUARED =",F10.2/)
      WRITE(6,914)  SUMT
  914 FORMAT(" SUM T =", F10.2)
C
C         KENDALS COEFFICIENT OF CONCORDANCE
      D=(M*M*(N*N*N-N)/12)-M*NSUMT/12
      C=9999.
      IF (D.NE.0.) C=S/D
C
      NOF = N - 1
C
      CHISQ = M * NOF * C
      IF (C.EQ.9999.) WRITE (6,917)
  917 FORMAT (/1X,"KENDALLS COEFFICIENT OF CONCORDANCE IS INDETERMINATE"
     */)
C
      WRITE(6,916)  C, M, N
  916 FORMAT(/ 1X,"KENDALLS COEFICIENT OF CONCORDANCE =",F10.3,5X,
     * "M ="I3,5X,"N ="I3/)
      IF (M.LE.7.AND.N.LE.20) GO TO 130
C
      DF=NOF
      CALL MDCH (CHISQ,DF,P,IER)
      P=1.-P
      WRITE (6,918) CHISQ,NOF,P
  918 FORMAT(/" CHI-SQUARE =",F10.3,5X,"DF =",I4,5X,"P =",F6.4)
      PTEST=.05
      DO 320 J=1,2
      KNOT="   "
      IF (P.GE.PTEST)KNOT="NOT"
      WRITE (6,922)KNOT,PTEST
  922 FORMAT (1X,"RANK ORDER ",A3," CONSISTANT AT",F4.2," LEVEL.")
      PTEST=.01
  320 CONTINUE
      RETURN
C
  130 CONTINUE
      TEST = .05
      PTEST=CCH(M,N,1)
      DO 325 J=1,2
      KNOT="   "
      IF (S.LE.PTEST) KNOT="NOT"
      WRITE (6,923) KNOT, TEST, PTEST
      TEST = .01
```

TABLE C-1. (Continued)

```
SUBROUTINE CONDOR      74/74    OPT=1 TRACE                       FTN 4.6+439          04/03/70  15.30.34

                      PTEST=CCW(M,N,2)                                                      TPP1      1494
                  325 CONTINUE                                                              TPP1      1495
                  920 FORMAT (1X,"RANK ORDER ",A3, " CONSISTANT AT ",F4.2," LEVEL. CRITI TPP1      1496
  175                *CAL S = ",F7.2)                                                       TPP1      1497
                      RETURN                                                                TPP1      1498
                      END                                                                   TPP1      1499


     SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS       DEF LINE      REFERENCES
    1  CONDOR           1          162         176

VARIABLES        SN  TYPE              RELOCATION
  1133  A             REAL          ARRAY      CDATA         REFS        3
   620  C             REAL                                   REFS      139        140        144    DEFINED       134        135
  1142  CCW           REAL          ARRAY                    REFS       11        166        172    DEFINED        13         15         17
                                                               21       25         29         31         34         38         42
   622  C-ISQ         REAL                                   REFS      150        152    DEFINED        139
   617  D             REAL                                   REFS    2*135    DEFINED        133
   623  DF            REAL                                   REFS      150    DEFINED        149
     0  HEADER        REAL          ARRAY      IOD           REFS        6         99
   605  I             INTEGER                                REFS     4*64         87       4*91    DEFINED        63         46         90
   625  IER           INTEGER                                REFS      150
   601  J             INTEGER                                REFS       55         56         66         72         95         99      2*110
                                                            2*111      114        115    DEFINED         53         99        1.3        155
                                                              167
   606  JAV           INTEGER                                REFS       72         88    DEFINED         70         87
 25374  JNAME         INTEGER       ARRAY      CDATA         REFS        3        110        111    DEFINED       110
 25706  JSUBL         INTEGER       ARRAY      CDATA         REFS        3          8         54
   276  JTEMP         INTEGER       ARRAY                    REFS       1.         74         76         87    DEFINED        54
    15  JTIE          INTEGER                  IOD           REFS        6
   610  JV            INTEGER                                REFS       77    DEFINED         76
   612  J1            INTEGER                                REFS       53         86    DEFINED         42
   611  J2            INTEGER                                REFS       82         83         86    DEFINED         79
   603  K             INTEGER                                REFS     2*54         66         7*         71         74         79         43
                                                              106      111      3*114        115        121        126
                                                          DEFINED       57         45         69         75        107         1.        111
                                                              113      119        121        125
   627  KNOT          INTEGER                                REFS      154        170    DEFINED        156        157        155        160
   602  L             INTEGER                                REFS       57         59         62         53         69         75         45
                                                          DEFINED       55
   576  M             INTEGER                                REFS       53        109      3*133        139        144        147        166
                                                              172  DEFINED         48
   577  N             INTEGER                                REFS       59         62         63         65         95        102        105
                                                              111      113        116        119        121        125      4*133        137
                                                              144      147        166        172    DEFINED         50
     3  NAME          INTEGER       ARRAY      CDATA         REFS        3
     .  NBR           INTEGER                  CDATA         REFS        3         50
   3.7  NDASH         INTEGER                                REFS      102      2*119    DEFINED         12
   621  NDF           INTEGER                                REFS      139        149        152    DEFINED        137
   607  NEG           INTEGER                                REFS       7*         81         82         9.    DEFINED         74         78
                                                               92
    13  NFUZ          INTEGER                  IOD           REFS        6
```

TABLE C-1. (Continued)

```
        SUBROUTINE CONDOR     74/74   OPT=1 TRACE                  FTN 4.6+439        04/05/90  15.33.36

  VARIABLES       SN  TYPE            RELOCATION
        1  NJ         INTEGER                CDATA      REFS       3       48
       10  NOTCOM     INTEGER                IOO        REFS       6
       14  NPRINT     INTEGER                IOO        REFS       6
       11  NPTYP1     INTEGER                IOO        REFS       6
       12  NPTYP2     INTEGER                IOO        REFS       6
    25541  NSIZE      INTEGER     ARRAY      CDATA      REFS       3       55
      600  NSUMT      INTEGER                           REFS      64       91       96      133   DEFINED     51      64
                                                           91
        2  NNT        INTEGER                CDATA      REFS       3
      624  P          REAL                              REFS     150      151      152      157   DEFINED    151
      626  PTEST      REAL                              REFS     157      158      169      170   DEFINED    154     160
                                                          160    172
      631  R          REAL        ARRAY                 REFS      1.      114      121      126   DEFINED    105     114
      615  RBAR       REAL                              REFS     126      127  DEFINED      114
      616  S          REAL                              REFS     126      127      135      169   DEFINED    124     126
      614  SUMR       REAL                              REFS     115      119  DEFINED      107      115
      613  SUMT       REAL                              REFS      97      129  DEFINED       96       97
      632  TEST       REAL                              REFS     170  DEFINED      165      171
    44553  WI         REAL        ARRAY      CDATA      REFS       3
    25227  WJ         REAL        ARRAY      CDATA      REFS       3
    25706  XSUBL      REAL        ARRAY      CDATA      REFS       7        8      111      114      115
                                                     DEFINED      66       72       85
      604  XX         REAL                              REFS      60       66       72       84       88
                                                     DEFINED      59       60       71       83       84

  FILE NAMES          MODE
        TAPE6         FMT                     WRITES       99      102      111      113      121      127      129     140
                                                 144      152      158      170

  EXTERNALS           TYPE   ARGS      REFERENCES
        MOCH                   4          150

  INLINE FUNCTIONS    TYPE   ARGS          DEF LINE  REFERENCES
        IABS        INTEGER    1  INTRIN               78       47

  STATEMENT LABELS                DEF LINE   REFERENCES
        0  30                        58         57
        0  40                        66         65
       40  45                        69         62
        0  50                        72         69
       64  60                        81         77
        0  70                        84         86
      114  80                        93         75         80         81
        0  90                        94         53
        0  100                      106        105
        0  110                      110        109        113
        0  120                      126        125
      314  130                      164        147
        0  320                      161        155
        0  325                      173        167
      357  902         FMT          100         99
      376  904         FMT          103        102
      407  906         FMT          112        111
      422  908         FMT          120        119
      431  910         FMT          122        121
      442  912         FMT          128        127
      455  914         FMT          130        129
```

TABLE C-1. (Continued)

```
        SUBROUTINE CONCOR      74/74    OPT=1 TRACE                        FTN 4.6+439         04/08/80  15.38.36

 STATEMENT LABELS                      DEF LINE    REFERENCES
    5.1   916       FMT                  145         144
    463   917       FMT                  141         140
    520   918       FMT                  153         152
    551   920       FMT                  174         170
    534   922       FMT                  159         158

 LOOPS   LABEL      INDEX       FROM-TO     LENGTH     PROPERTIES
      7   90       * J           53 94       106B                NOT  INNER
     16   30         K           57 58         3B      INSTACK
     35   40         K           65 66         2B      INSTACK
     45   50         K           69 72         5B      INSTACK
     55   80       * K           75 93        36B                NOT  INNER
     76   70         I           86 88         5B      INSTACK
    122            * J           99 99         4B                EXT  REFS
    132            * K          102 102        4B                EXT  REFS
    142  100         K          105 106        2B      INSTACK
    147  110       * J          109 116       32B                EXT  REFS   NOT INNER
    172  110         K          113 116        4B      INSTACK
    206            * K          119 119        4B                EXT  REFS
    224  120         K          125 126        4B      INSTACK
    300  320       * J          155 161       13B                EXT  REFS
    322  325       * J          167 173       17B                EXT  REFS

 COMMON BLOCKS   LENGTH
        CDATA     21306
        IDD          14

 STATISTICS
   PROGRAM LENGTH                 1572B      890
   CM LABELED COMMON LENGTH      51510B    21320
```

TABLE C-1. (Continued)

```
SUBROUTINE COMPARE     74/74    OPT=1 TRACE                    FTN 4.6+459        04/09/80  15.36.36

 1          SUBROUTINE COMPARE                                                    TPP1     1500
            COMMON /CDATA/ NBR ,NJ,NNT, NAME(2,300),A(100,100),WI(300),WJ(300) TPP1     1501
           +         , JNAME(101),NSIZE(101),JSUBL(100,101)                       TPP1     1502
            COMMON/RANK/LISTC(100,3),LIST(100),LAB(3)                             TPP1     1503
 5          DATA LAB/5H     ,4HPREF,5H     /                                      TPP1     1504
            NK=3                                                                  TPP1     1505
            NJ=2                                                                  TPP1     1506
            IF (LAB(3).NE."FUZZY") NK=2                                           TPP1     1507
            DO 10 K=1,NK                                                          TPP1     1508
 10         DO 10 L=K,NK                                                          TPP1     1509
            IF (K.EQ.L) GO TO 10                                                  TPP1     1510
            JNAME(1)=LAB(K)                                                       TPP1     1511
            JNAME(2)=LAB(L)                                                       TPP1     1512
            NSIZE(1)=NBR                                                          TPP1     1513
 15         NSIZE (2)=NBR                                                         TPP1     1514
            DO 5 I=1,NBR                                                          TPP1     1515
            JSUBL(I,1)=LISTC(I,K)                                                 TPP1     1516
            JSUBL(I,2)=LISTC(I,L)                                                 TPP1     1517
          5 CONTINUE                                                              TPP1     1518
 20         CALL CONCOR                                                           TPP1     1519
         10 CONTINUE                                                              TPP1     1520
            LAB(1)="     "                                                        TPP1     1521
            LAB(3)="     "                                                        TPP1     1522
            RETURN                                                                TPP1     1523
 25         END                                                                   TPP1     1524
```

```
SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS      DEF LINE       REFERENCES
    1  COMPARE        1             24

VARIABLES       SN  TYPE              RELOCATION
  1133  A           REAL          ARRAY    CDATA        REFS      2
    53  I           INTEGER                             REFS     [illegible]   [illegible]  DEFINED     16
 25374  JNAME       INTEGER       ARRAY    CDATA        REFS      2    DEFINED      12          13
 25706  JSUBL       INTEGER       ARRAY    CDATA        REFS      2    DEFINED      17          18
    51  K           INTEGER                             REFS     10         11      12          17   DEFINED
    52  L           INTEGER                             REFS     11         13      18     DEFINED      10
   520  LAB         INTEGER       ARRAY    RANK         REFS      4          8      12          13   DEFINED      5      22
                                                                 23
   454  LIST        INTEGER       ARRAY    RANK         REFS      4
     0  LISTC       INTEGER       ARRAY    RANK         REFS      4         17      19
     3  NAME        INTEGER       ARRAY    CDATA        REFS      2
     0  NBR         INTEGER                CDATA        REFS      2         14      15          16
     1  NJ          INTEGER                CDATA        REFS      2    DEFINED       7
    50  NK          INTEGER                             REFS      9         10 DEFINED           6        8
 25541  NSIZE       INTEGER       ARRAY    CDATA        REFS      2    DEFINED      14          15
     2  NNT         INTEGER                CDATA        REFS      2
 24553  WI          REAL          ARRAY    CDATA        REFS      2
 25227  WJ          REAL          ARRAY    CDATA        REFS      2
```

TABLE C-1. (Continued)

```
      SUBROUTINE COMPARE    74/74   OPT=1 TRACE                        FTN 4.6+439        04/08/80  15.38.36

EXTERNALS           TYPE   ARGS        REFERENCES
      CONCOR                 4               2
STATEMENT LABELS                   DEF LINE   REFERENCES
    0  5                               19         16
   36  10                              21          9         10         11

LOOPS  LABEL      INDEX      FROM-TO     LENGTH     PROPERTIES
   10  10       * K            9 21        33B                EXT REFS  NOT INNER
   12  10       * L           10 21        27B                EXT REFS  NOT INNER
   30  5          I           16 19         4B        INSTACK

COMMON BLOCKS    LENGTH
      CDATA      21306
      RANK         403

STATISTICS
  PROGRAM LENGTH               54B       44
  CM LABELED COMMON LENGTH   52315B   21709
```

TABLE C-1. (Continued)

```
SUBROUTINE REQUIRE    74/74    OPT=1 TRACE                    FTN 4.6+439        04/08/80  15.14.16

      SUBROUTINE REQUIRE
      COMMON/HELP/NW,IND(50,6),ICAT(300),NAM(2),JCHECK(300),ITT,IMAX,JMAX
      COMMON /CDATA/ NBR ,NJ,NMT, NAME(2,300),A(100,100),MI(300),MJ(101)
     *            , JNAME (01),NSIZE(101),JSUBL(100 101)
      DIMENSION IELEM(300,2),ISUM(300),JPROJ(300)
      DATA IR/0/
      IF (IR.NE.0) GO TO 55
      REWIND 9
      DO 50 I=1,300
      READ (9,100)(IELEM(I,J),J=1,2)
      IX=I
      IF (EOF(9).NE.0.) GO TO 40
  100 FORMAT(2A10)
      IR=1
   50 CONTINUE
      IX=301
   40 NELE=IX-1
      WRITE (6,950)
  95. FORMAT (////T10,"INDEX LIST OF REQUIREMENTS AND PROJECTS")
      WRITE (6,101) (I,IELEM(I,1),IELEM(I,2),I=1,NELE)
  101 FORMAT (/4(I4,2X,2A10,"/"))
   55 IC=1
      II=0
      DO 65 I=1,IMAX
      ISUM(I)=0
   65 JPROJ(I)=0
      DO 11 I=1,NW
      K=IABS(JSUBL(I,NJ))+ITT
      IP=0
      N=1
      DO 10 J=1,NELE
      IF (NAME(1,K).EQ.IELEM(J,1)) GO TO 5
      GO TO 10
    5 II=II+1
      JPROJ(II)=IELEM(J,2)
      DO 15 M=1,ITT
   15 IF (JPROJ(II).EQ.NAME (1,M))ISUM(II)=IND(M)
      IF (JSUBL(I,NJ).LT.0.AND. N.EQ.1) ISUM(II)=-ISUM(II)
      IF (N.GT.1) ISUM(II)=-ISUM(II)
      N=N+1
      IP=IP+1
      IC=IC+1
   10 CONTINUE
      IF (IP.EQ.0)WRITE (6,900) NAME(1,K)
  900 FORMAT (/1X,A10," IS NOT IN REQUIREMENT INDEX"/)
   11 CONTINUE
      DO 20 I=1,IC
      DO 20 J=I,IC
      IF (I.EQ.J) GO TO 20
      IF (IABS(ISUM(I)).NE.IABS(ISUM(J))) GO TO 20
      IF (ISUM(J).GT.0.AND.ISUM(J+1).LT.0) ISUM(J+1)=IABS(ISUM(J+1))
      ISUM(J)=0
   20 CONTINUE
      M=0
      DO 25 I=1,IC
   25 IF (ISUM(I).NE.0) M=M+1
   30 K=0
```

TABLE C-1. (Continued)

```
SUBROUTINE REQUIRE      74/74    OPT=1 TRACE                    FTN 4.6+439        10/30/79  15.39.16

                      DO 35 I=1,IC                                                  TPP1      1542
                      IF (ISUM(I).EQ.0) GO TO 31                                    TPP1      1543
                      GO TO 35                                                      TPP1      1544
                   31 IF (I.GT.M) GO TO 35                                          TPP1      1545
                      DO 32 J=I,IC                                                  TPP1      1546
                      K=1                                                           TPP1      1547
                   32 ISUM(J)=ISUM(J+1)                                             TPP1      1548
                   35 CONTINUE                                                      TPP1      1549
                      IF (K.EQ.1) GO TO 30                                          TPP1      1590
                      NJ=M                                                          TPP1      1591
                      NSIZE(NJ)=M                                                   TPP1      1592
                      DO 45 I=1,M                                                   TPP1      1593
                   45 JSUBL(I,NJ)=ISUM(I)                                           TPP1      1594
                      RETURN                                                        TPP1      1595
                      END                                                           TPP1      1596


   SYMBOLIC REFERENCE MAP (R=2)

 ENTRY POINTS     DEF LINE     REFERENCES
    1  REQUIRE        1          71

 VARIABLES      SN  TYPE              RELOCATION
  1133  A           REAL        ARRAY    COATA     REFS       3
   323  I           INTEGER                        REFS      10      11     3*20      25      27      29      36
                                                    45      49      50      56      59      61      63     2*70
                                                DEFINED       9      20      24      27      47      55      58
                                                    69
   327  IC          INTEGER                        REFS      42      47      49      55      58      62
                                                DEFINED      22      42
   455  ICAT        INTEGER     ARRAY    HELP      REFS       2
   335  IELEM       INTEGER     ARRAY              REFS       6    2*20      32      35   DEFINED     19
   330  II          INTEGER                        REFS      34      35    2*37    2*39    2*39
                                                DEFINED      23      34
  1011  IMAX        INTEGER              HELP      REFS       2      24
     1  IND         INTEGER     ARRAY    HELP      REFS       2      37
   332  IP          INTEGER                        REFS      41      44   DEFINED      29      41
   247  IR          INTEGER                        REFS       7  DEFINED       6      14
  1455  ISUM        INTEGER     ARRAY              REFS       6      30      39    2*56    3*51      55      59
                                                    64      70  DEFINED      25      37      38      33      51
                                                    92      66
  1607  ITT         INTEGER              HELP      REFS       2      29      36
   325  IX          INTEGER                        REFS      17  DEFINED      11      16
   324  J           INTEGER                        REFS      10      32      35      45      50    4*51      62
                                                  2*64  DEFINED      18      31      49      52
  1133  JCHECK      INTEGER     ARRAY    HELP      REFS       2
  1011  JMAX        INTEGER              HELP      REFS       2
 25374  JNAME       INTEGER     ARRAY    COATA     REFS       3
  2141  JPROJ       INTEGER     ARRAY              REFS       5      37  DEFINED      26      35
 25756  JSUBL       INTEGER     ARRAY    COATA     REFS       3      28      35  DEFINED      73
   331  K           INTEGER                        REFS      32      44      66  DEFINED      28      57      62
   334  M           INTEGER                        REFS    2*37      56      61      67      68      64
                                                DEFINED      36      54      56
   333  N           INTEGER                        REFS      38      39      40  DEFINED      32      42
```

TABLE C-1. (Continued)

```
      SUBROUTINE REQUIRE    74/74   OPT=1 TRACE                     FTN 4.6+439        84/08/8- 15.38.36

VARIABLES      SN  TYPE               RELOCATION
  1131  NAM        INTEGER    ARRAY    HELP        REFS        2
     3  NAME       INTEGER    ARRAY    CDATA       REFS        3        32       37        44
     0  NBR        INTEGER             CDATA       REFS        3
   326  NELE       INTEGER                         REFS        28       31    DEFINED      17
     1  NJ         INTEGER             CDATA       REFS        7        26       35        60       78
 25541  NSIZE      INTEGER    ARRAY    CDATA       REFS        3     DEFINED     64
     0  NV         INTEGER             HELP        REFS        2        27    DEFINED      67
     2  NWT        INTEGER             CDATA       REFS        8
 24553  WI         REAL       ARRAY    CDATA       REFS        3
 25227  WJ         REAL       ARRAY    CDATA       REFS        3

FILE NAMES         MODE
      TAPE6        FMT                        WRITES       10       20       44
      TAPE9        FMT                        READS        10    MOTION       6

EXTERNALS            TYPE   ARGS        REFERENCES
      EOF          REAL      1              12

INLINE FUNCTIONS    TYPE   ARGS       DEF LINE  REFERENCES
      IABS         INTEGER   1  INTRIN                  26       2448      51

STATEMENT LABELS                 DEF LINE   REFERENCES
  1..  5                           34         32
  136  10                          43         31        33
    0  11                          46         27
    4  15                          37         36
  173  20                          53         47        49       49       56
    .  25                          54         55
  206  30                          57         56
  212  31                          61         59
    0  32                          64         62
  224  35                          65         54        66       61
   33  4.                          17         12
    0  45                          70         69
    0  50                          15          9
   53  55                          22          7
    0  65                          26         24
  252  101        FMT              13         10
  304  101        FMT              21         20
  314  989        FMT              45         44
  265  958        FMT              19         18

LOOPS  LABEL    INDEX      FROM-TO    LENGTH    PROPERTIES
    6  50        * I         9 15       249             EXT REFS   EXITS   NOT INNER
   11            * J        10 18       110             EXT REFS
   42            * I        28 28       105             EXT REFS
   57  65          I        24 26        30     INSTACK
   64  11        * I        27 46       650             EXT REFS  NOT INNER
   74  10        * J        31 43       450             NOT INNER
  111  15          M        36 37        50     INSTACK
  152  20        * I        47 53       230             NOT INNER
  160  20          J        48 53       110      OPT
  201  25          I        55 56        40     INSTACK
  210  35        * I        50 65       170             NOT INNER
  220  32          J        62 64        30     INSTACK
  240  45          I        69 70        20     INSTACK
```

TABLE C-1. (Continued)

```
        SUBROUTINE REQUIRE     74/74    OPT=1 TRACE                  FTN 4.6+439         04/08/80  15.36.36

   COMMON BLOCKS    LENGTH
        HELP          306
        CDATA       21306

   STATISTICS
      PROGRAM LENGTH              2615B     1421
      CM LABELED COMMON LENGTH   53384B    22212
```

TABLE C-1. (Continued)

LOAD MAP - DOBBINS CYBER LOADER 1.2-439 04/04/80 16.52.36.

FWA OF THE LOAD 111
LWA+1 OF THE LOAD 167234

TRANSFER ADDRESS -- DOBBINS 62435

PROGRAM AND BLOCK ASSIGNMENTS.

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER	LEVEL	HARDWARE	COMMENTS
/DDATA/	111	51472							
/HELP/	51603	1612							
/RANK/	53415	623							
/IOD/	54240	16							
DOBBINS	54256	12465	LGO	04/08/80	FTN	4.6	439	666X I	OPT=1 TRACE
/WORK/	66743	24494							
INPUT	113347	3323	LGO	04/08/80	FTN	4.6	439	666X I	OPT=1 TRACE
FREQ	116672	313	LGO	04/08/80	FTN	4.6	439	666X I	OPT=1 TRACE
MATRIX	115205	657	LGO	04/08/80	FTN	4.6	439	666X I	OPT=1 TRACE
WEIGHT	116064	513	LGO	04/08/80	FTN	4.6	439	666X I	OPT=1 TRACE
ORDER	116577	643	LGO	04/08/80	FTN	4.6	439	666X I	OPT=1 TRACE
PREF	117402	1172	LGO	04/08/80	FTN	4.6	439	666X I	OPT=1 TRACE
FUZZY	120574	338	LGO	04/08/80	FTN	4.6	439	666X I	OPT=1 TRACE
CONCOR	121074	1572	LGO	04/08/80	FTN	4.6	439	666X I	OPT=1 TRACE
COMPARE	122666	54	LGO	04/08/80	FTN	4.6	439	666X I	OPT=1 TRACE
REQUIRE	122742	2615	LGO	04/08/80	FTN	4.6	439	666X I	OPT=1 TRACE
NDCH	125557	216	UL-LIB	07/05/79	FTN	4.6	439	666X I	OPT=1
MDNOR	125775	26	UL-LIB	07/05/79	FTN	4.6	439	666X I	OPT=1
ERFC	126015	221	UL-LIB	07/05/79	FTN	4.6	439	666X I	OPT=1
USETIO	126236	25	UL-LIB	07/05/79	FTN	4.6	439	666X I	OPT=1
GAMMA	126263	264	UL-LIB	07/05/79	FTN	4.6	439	666X I	OPT=1
UERTST	126547	252	UL-LIB	07/05/79	FTN	4.6	439	666X I	OPT=1
/XPRAMSX/	127022	36							
PRAM	127057	631	UL-ALTLIB	04/04/79	FTN	4.2	74355	666X I	OPT=1
/STP.END/	127710	1							
/FCL.C./	127711	23							
/Q8.IO./	127734	132							
Q8NTRY=	130066	8	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		FCL INITIALIZATION ROUTINE.
CODIO=	130066	64	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		COMMON CODED I/O ROUTINES AND CONSTANTS.
DECODE=	130152	73	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		FORMATTED READ FROM CORE.
EOF	130245	16	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		TEST FOR END OF FILE STATUS.
FLTIN=	130263	156	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		COMMON FLOATING INPUT CONVERTER.
FMTAP=	130441	352	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		CRACK APLIST AND FORMAT FOR KODER/KRAKER.
FORUTL=	131013	16	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		FCL MISC. UTILITIES.
GETFIT=	131031	42	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		LOCATE AN FIT GIVEN A FILE NAME.
KRAKER=	131073	406	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		PROCESS FORMATTED FORTRAN INPUT.
OUTC=	131501	174	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		FORMATTED WRITE FORTRAN RECORD.
SQRT	131675	43	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		COMPUTE THE SQUARE ROOT OF X. OPT=ALL.
SYSAIST	131740	62	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		WITH LIBRARY LINK TO ERROR MESSAGE PROCESSOR.
XTOY=	132022	51	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		REAL BASE TO REAL POWER.
FECNSK=	132073	41	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		INITIALIZE CONSTANTS.
FLTOUT=	132134	311	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		COMMON FLOATING OUTPUT CODE
FORSYS=	132445	603	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		FORTRAN OBJECT LIBRARY UTILITIES.
INCOM=	133250	276	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		COMMON INPUT FORMATTING CODE
INPC=	133546	168	SL-FORTRAN	11/17/77	COMPASS	3.	3-439		FORMATTED READ FORTRAN RECORD.

TABLE C-1. (Concluded)

```
LOAD MAP - DIMAINS                                CYBER LOADER 1.2-439      04/28/81  16.32.36.

FODER=        133726     456 SL-FORTRAN  11/17/77 COMPASS  3. 3-439        OUTPUT FORMAT INTERPRETER.
OUTCOM=       134404     154 SL-FORTRAN  11/17/77 COMPASS  3. 3-439        COMMON OUTPUT CODE
FEWIND=       134560      41 SL-FORTRAN  11/17/77 COMPASS  3. 3-439        POSITION FILE AT BEGINNING-OF-INFORMATION.
GOTOER=       134621      14 SL-FORTRAN  11/17/77 COMPASS  3. 3-439        COMPUTED GO TO ERROR PROCESSOR.
ALOG          134635      73 SL-FORTRAN  11/17/77 COMPASS  3. 3-439        COMPUTE COMMON AND NATURAL LOGARITHMS. OPT=ALL.
EXP           134730      75 SL-FORTRAN  11/17/77 COMPASS  3. 3-439        EXPONENTIAL FUNCTION, E TO POWER X. OPT=ALL.
SINCOS=       135025      66 SL-FORTRAN  11/17/77 COMPASS   . 3-439        TRIGONOMETRIC SINE OR COSINE OF X. OPT=ALL.
SYSAID=       135113       1 SL-FORTRAN  11/17/77 COMPASS  3. 3-439        LINK BETWEEN SYSAID AND INITIALIZATION CODE.
MCI.RM        135114     233 SL-SYSIO    03/30/77 COMPASS  3. 3-439
/ABS.RM/      135347      10
/CON.RM/      135357       6
/PUT.RT/      135365      11
RLEQ.RM       135376      42 SL-SYSIO    03/30/77 COMPASS  3. 3-439
4AR.SQ        135440     260 SL-SYSIO    03/30/77 COMPASS  3. 3-439
CIO.RM        135723      40 SL-SYSIO
MOVE.RM       135760      64 SL-SYSIO
OSUB.RM       136044      71 SL-SYSIO
/JMPS.RM/     136135      11
/OPEN.FO/     136146       7
OPEN.SQ       136155     257 SL-SYSIO
OPEK.SQ       136434      14 SL-SYSIO
/TERM.RM/     136450       1
/PUT.FO/      136451       7
PUT.SQ        136460    1413 SL-SYSIO
/CLSF.FO/     140073       7
CLSF.RM       140102      22 SL-SYSIO
/GET.BT/      140124       5
BTRT.SQ       140131     115 SL-SYSIO
WEOR.SQ       140246     150 SL-SYSIO
/SKFL.FO/     140416       7
SKFL.SQ       140425      51 SL-SYSIO
ERR.RM        140476     406 SL-SYSIO
CHHR.SQ       141104       7 SL-SYSIO
/MEMC.RM/     141113       3
/OPES.FO/     141116       1
OPEN.RM       141117     237 SL-SYSIO
CLSF.SQ       141356     134 SL-SYSIO
/CLSV.FO/     141512       7
CLSV.SQ       141521     137 SL-SYSIO
/REN.FO/      141660       7
REN.SQ        141667      42 SL-SYSIO
/GET.FO/      141731       7
/RPRR.XX/     141740       1
/GET.RT/      141741      11
GET.SQ        141752    1062 SL-SYSIO
Z.SQ          143034     101 SL-SYSIO
FSU.SQ        143135     105 SL-SYSIO
SYS.RM        143243      37 SL-SYSLIB   07/14/79 COMPASS  3. 3-439        PROCESS SYSTEM REQUEST.
 //           143302   23732

    1.043 CP SECONDS          1573939 CM STORAGE USED                 121 TABLE MOVES
```

TABLE C-2. LIBRARY SUBROUTINE PRAM

```
SUBROUTINE PRAM( FVALUE, NV, JA ), RETURNS( SPECIAL, CHANGE )

DESCRIPTION
  PRAM IS A TERMINAL ROUTINE WHICH IS USED TO ENTER FLOATING
  POINT DATA IN FREE FORMAT FORM WHERE PRECISE FORMATS ARE NOT
  PRACTICAL. WORDS ARE SEPARATED BY NON-NUMERICS SUCH AS BLANKS
  OR COMMAS.

INPUT
  JA=0 CAUSES  NV  KEY WORDS TO BE LOADED FROM ARRAY FVALUE.
  JA=POSITIVE VALUE  WILL CAUSE ONE CARD OR KEYBOARD ENTRY TO BE
     INTERPRETED FOR UP TO  JA  FLOATING POINT PARAMETERS.
  JA=NEGATIVE VALUE  WILL CAUSE ONE OR MORE CARD OR KEYBOARD
     ENTRIES TO BE INTERPRETED UNTIL  IABS(JA)  FLOATING POINT
     PARAMETERS ARE INTERPRETED.
  KEY WORDS  MAY BE ENTERED TO CAUSE A NON-STANDARD RETURN AS A
     WAY OF BREAKING OUT OF READ LOOPS, ETC.
  SPECIAL ENTRY POINTS
     PRAMIN(5LTAPE3)     SET INPUT FILE TO DESIRED UNIT
     PRAMOUT(5LTAPE9)    SET OUTPUT FILE TO DESIRED UNIT
     PRINT ON            SETS PRAM TO PRINT ALL INPUT RECORDS
     PRINT OF            OPPOSITE OF PRINT ON (DEFAULT)
     PRAMS               CALLING PROGRAM SHOULD HAVE LABELED COMMON
                            COMMON/XPRAMSX/WORD(8),DUM(22)
                         THIS ENTRY WILL BYPASS CARD READ AND
                         INTERPRET THE ARRAY WORD IN COMMON.
                         ARGUMENTS TO THIS ENTRY POINT ARE THE SAME
                         AS PRAM.

OUTPUT
  NV = NUMBER OF PARAMETERS THAT WERE FOUND (REST ARE SET TO ZERO)
  FVALUE = ARRAY OF FLOATING POINT PARAMETERS
  CHANGE = NON-STANDARD RETURN IF A C ( FOR DATA CORRECTION ) IS
     FOUND IN THE DATA STRING.
  SPECIAL = NON-STANDARD RETURN IF A KEY WORD ( SUCH AS END ) IS
     FOUND STARTING IN COLUMN 1. NV IS RETURNED WITH THE KEY WORD
     NUMBER AND FVALUE(1) IS RETURNED WITH THE KEY WORD.
     THE FOLLOWING HAVE SPECIAL FUNCTIONS AND MAY NOT BE USED AS
     KEY WORDS. ALL EXCEPT PRAM SHOULD START IN COLUMN 1.
         PREV       RETURNS PREVIOUS VALUES IN ARRAY FVALUE
         REMARK     PRINTS REMAINDER OF CARD AS COMMENTS
         PRINT ON   PRINTS ALL FOLLOWING INPUT CARDS ON OUTPUT FILE
         PRINT OFF  TURNS OFF PRINTING OF INPUT RECORDS
         NONE       RETURNS ZEROS FOR FVALUE
         PRAM       LISTS VARIABLES ON THE CARD IN WHICH IT APPEARS
                    (MUST BE IN COLUMNS 70-74)
         STOP       GOES TO AN IMMEDIATE PROGRAM STOP

REMARKS
     SPECIAL SYMBOL * TERMINATES INTERPRETATION OF THE RECORD AT
     THAT POINT.

     EXAMPLE..SAMPLE PROGRAM WILL FIRST SET INPUT AND OUTPUT FILES
     TO TAPE3 AND TAPE9 RESPECTIVELY, THEN READ 10 VARIABLES
     PER CARD INTO THE ARRAY X UNTIL THE WORD END APPEARS IN THE
     INPUT STRING.
     IF A C APPEARS IN THE STRING, THE PROGRAM WILL RE-READ THE
     VARIABLE TO BE CORRECTED AND FINISH READING THE DATA STRING
     FROM THAT POINT.
        PROGRAM MAIN(INPUT,OUTPUT,TAPE3=INPUT,TAPE9=OUTPUT)
        DIMENSION X(10)
        DATA IKEY/3HEND/
        CALL PRAMIN(5LTAPE3)
        CALL PRAMOUT(5LTAPE9)
        CALL PRAM(IKEY,1,0)
     99 JA=10
        NV=1
      1 CALL PRAM(X(NV),NV,JA),RETURNS(10,20)
            .
        GO TO 99
     20 JJ=1
        CALL PRAM(XV,NN,JJ)
        NV=XV+.1
        JA=10-NV+1
        GO TO 1
     10 CONTINUE
        END
     EXAMPLE..DATA
        1.,2.,3.,4.,5.,6.,7.,8.,9.,10.
        11,12.,13.,14,15,19C
        5
        16.,17,18,19,20
        END

REFERENCE
```

TABLE C-2. (Continued)

```
      SUBROUTINE  PRAM( FVALUE, NV, JA ),  RETURNS( SPECIAL, CHANGE )
      DIMENSION FVALUE(500), A(80), AN(13), W(10)
      COMMON /PPRAMS/  WORD(8), DUM, NKEY, WORDKEY(20)
      LOGICAL  LIST
      EQUIVALENCE  ( JIN, FILEIN ),  ( JOUT, FILEOUT )
C
      DATA  LIST / .FALSE. /
      DATA  AN /1H0,1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9,1H.,1H-,1H+ /
      DATA  W /  0., 1., 2., 3., 4., 5., 6., 7., 8., 9./
      DATA  PERIOD/1H./,               AMINUS/1H-/, APLUS/1H+/, ALAST/1H*/
      DATA  NKEY/0/
      DATA  FILEIN/5LINPUT/, FILEOUT/6LOUTPUT/
C
      NF = 0
      IF( JA .NE. 0 )  GO TO 10
      NKEY = NV
      IF( NV .LE. 0 )  RETURN
      DO 5 J = 1, NKEY
    5 WORDKEY(J) = FVALUE(J)
      RETURN
C         THIS ENTRY BYPASSES CARD READ AND INTERPRETS ARRAY IN COMMON.
      ENTRY  PRAMS
      NF = 0
      GO TO  12
C
   10 CONTINUE
      READ(JIN,905) (WORD(J), J=1,8 )
  905 FORMAT( 8A10 )
      IF( WORD(1) .NE. 5HREMARK )  GO TO 12
      WRITE(JOUT,900)  ( WORD(J), J=2,8 )
      GO TO 10
   12 IF( LIST.OR. WORD(8).EQ.4HPRAM )  WRITE(JOUT,900)  WORD
  900 FORMAT(1X8A10)
C
      IF( NF .NE.0 ) GO TO 15
      IF( WORD(1) .NE. 10HPRINT ON   )  GO TO 16
      LIST = .TRUE.
      GO TO 10
   16 IF( WORD(1) .NE. 10HPRINT OFF ) GO TO 17
      LIST = .FALSE.
      GO TO 10
   17 NA = IABS( JA )
      IF( WORD(1) .EQ. 4HPREV )  RETURN
      IF( WORD(1) .EQ. 4HSTOP )  STOP 777
      NV = 0
      NCHANGE = 0
      DO 50 J=1,NA
   50 FVALUE(J) = 0.0
      IF( WORD(1) .EQ. 4HNONE )  RETURN
   15 NF = NF + 1
C
      IF( NKEY .LE. 0 )  GO TO 40
      NOPT = 0
C         CHECK FOR SPECIAL KEY WORDS
   15 DO 20 J = 1, NKEY
      IF( WORD(1) .NE. WORDKEY(J) ) GO TO 20
      FVALUE(1) = WORDKEY(J)
      NV = J
      RETURN  SPECIAL
   20 CONTINUE
      IF( NOPT .NE. 0 )  RETURN
C
   40 CONTINUE
      J3 = NV + 1
      DECODE(80,901,WORD)  A
  901 FORMAT(80A1)
C
C         SEARCH FOR START OF PARAMETERS
      J2 = 1
C         PROCESS PARAMETERS
      DO 400 JJ = J3, NA
      IF( J2 .GE. 80 )  GO TO 75
C         SKIP TO FIRST NUMERIC
      DO 70 J1=J2,80
C         AN * WILL TERMINATE THE PARAMETER LIST
      IF( A(J1) .EQ. ALAST )  GO TO 999
C         A  C WILL GIVE A NON-STANDARD RETURN TO CHANGE
      IF(A(J1).EQ.1HC.AND.(A(J1+1).EQ.1H .OR.A(J1+1).EQ.1H-)) NCHANGE=1
      DO 70  I=1,13
      IF( A(J1) .EQ. AN(I) )  GO TO 80
   70 CONTINUE
C         RUN OUT OF ARGUMENTS
C         IF JA IS NEGATIVE, READ ANOTHER CARD UNTIL NA IS SATISFIED
   75 IF( JA .LT. 0 )  GO TO 10
      GO TO 999
C         COMPUTE VALUE
   80 CONTINUE
C         CONVERT ALPHA TO NUMERIC
      ASIGN = +1.0
      VALUE = 0.0
      D10 = 1.
      E10 = 10.0
      IF( A(J1).EQ.APLUS ) GO TO 315
      IF( A(J1).NE.AMINUS) GO TO 320
      ASIGN = -1.0
  315 J1 = J1 + 1
  320      DO 360 J2 = J1,80
           DO 330 J=1,10
      IF( A(J2).EQ.AN(J) ) GO TO 340
```

TABLE C-2. (Concluded)

```
 330 CONTINUE
     IF( A(J2).NE.PERIOD) GO TO 370
     X10 = 1.0
     D10 = 0.1
     GO TO 360
 340 VALUE = VALUE*X10 + XV(J)*D10
     IF( D10.LT.1.0 ) D10 = D10 * 0.1
 360 CONTINUE
C
 370 FVALUE(JJ) = SIGN(VALUE,ASIGN)
     NV = JJ
 400 CONTINUE
C
 999 CONTINUE
     IF( NV .NE. 0 )  GO TO 998
     WRITE(JOUT,902)
 902 FORMAT(* YOU DID NOT ENTER KEYWORD OR NUMERIC VALUES - TRY AGAIN*)
     GO TO 10
 998 IF( NCHANGE .NE. 0 ) RETURN  CHANGE
C
     RETURN
     ENTRY PRINT ON
     LIST = .TRUE.
     RETURN
     ENTRY PRINT OF
     LIST = .FALSE.
     RETURN
     ENTRY OPTION
     READ 905, WORD
     ENTRY OPTIONS
     NOPT = 1
     GO TO 10
C        CHANGE INPUT FILE NAME ...  EX CALL PRAMIN( SLTAPES )
     ENTRY PRAMIN
     FILEIN = FVALUE(1)
     RETURN
C        CHANGE OUTPUT FILE NAME
     ENTRY PRAMOUT
     FILEOUT = FVALUE(1)
     END
```

TABLE C-3. TRANSLATION INDEX ARRANGEMENT SPECIAL PROGRAM

```
      PROGRAM MAIN      74/74   OPT=1                     FTN 4.6+439       06/21/90  10.33.07      PAGE    1

                PROGRAM MAIN (INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE9)
                DIMENSION  ARRAY(300,2)
                DO 10 I=1,300
                READ (5,1000)  ARRAY(I,1), ARRAY(I,2)
           1000 FORMAT (2A10)
                IF (EOF(5).NE.0.) GO TO 20
             10 CONTINUE
             20 IX=I-1
                CALL SORTLA( ARRAY,300,I ,2,-2, 1,10,1)
                CALL SORTLA( ARRAY,300,IX,2,-1,1,10,1)
                WRITE (9,2000) ((ARRAY(I,J),J=1,2),I=1,IX)
           2000 FORMAT (2A10)
                DO 15 I=1,250
                WRITE (6,2001) I, ARRAY(I,1), ARRAY(I,2)
             15 CONTINUE
           2001 FORMAT (1X,I5,2X,A10,2X,A10)
                WRITE (6,2002) IX
           2002 FORMAT (2X,"IX=",I6)
                END

      SYMBOLIC REFERENCE MAP (R=1)

 ENTRY POINTS
  6160  MAIN

 VARIABLES      SN  TYPE            RELOCATION
  6325  ARRAY       REAL        ARRAY                  6322  I            INTEGER
  6323  IX          INTEGER                            6324  J            INTEGER

 FILE NAMES         MODE
     0  INPUT                  2045  OUTPUT                  0  TAPE5     FMT          2045  TAPE6     FMT
  4106  TAPE9       FMT

 EXTERNALS          TYPE   ARGS
        EOF         REAL     1                    SORTLA            8

 STATEMENT LABELS
     0  10                                    0  15                               6175  20
  6263  1000     FMT                       6273  2000     FMT                     6303  2001     FMT
  6312  2002     FMT

 LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
  6162  10        * I          7 7        13B                  EXT REFS    EXITS
  6210            * I         11 11       14B                  EXT REFS  NOT INNER
  6211            * J         11 11       11B                  EXT REFS
  6226  15        * I         13 15       11B                  EXT REFS

 STATISTICS
   PROGRAM LENGTH                13040      708
   BUFFER LENGTH                 61513     3177
```

TABLE C-4. LIBRARY SUBROUTINE SORT

```
SUBROUTINE SORT( NA, MRD, M, N, KEYW, NSC, NCH, NSEQ )

DESCRIPTION
    THIS ROUTINE WILL TAKE A TWO DIMENSIONAL ARRAY CONTAINING
    NUMERIC OR ALPHANUMERIC DATA AND SORT IT ACCORDING TO SOME
    DESIRED SEQUENCE. THE VARIOUS COMBINATIONS AVAILABLE ARE
        CALL SORTNA(NA,MRD,...)   SORT NUMERICAL ASCENDING
        CALL SORTND(NA,MRD,...)   SORT NUMERICAL DESCENDING
    THE NUMERICAL SORT CONSIDERS THE SIGN AND MAGNITUDE OF A
    SINGLE 60 BIT WORD.
        CALL SORTLA(NA,MRD, ..)   SORT LOGICAL ASCENDING
        CALL SORTLD(NA,MRD,...)   SORT LOGICAL DESCENDING
    THE LOGICAL SORT IS USED FOR ALPHANUMERIC DATA AND THE
    SEQUENCE WILL BE AS SHOWN IN THE REMARKS PARAGRAPH. THIS
    SORT CONSIDERS INDIVIDUAL CHARACTERS AND MAY EXTEND OVER
    MORE THAN ONE WORD.

INPUT
    1  NA      ARRAY TO BE SORTED.  DIMENSION AS NA(MRD,LCOL)
    2  MRD     ROW DIM OF NA IN CALLING PROGRAM.
    3  M       NUMBER OF ROWS TO BE SORTED.
    4  N       NUMBER OF COLUMNS TO BE SORTED. (N .LE. LCOL)
               ALL WORDS OF NA(I,J) FOR J .GT. N WILL NOT BE
               REPOSITIONED DURING A SORT.
    5  KEYW    COL OR ROW SUBSCRIPT OF BEGINNING WORD OF THE
               FIELD TO BE SORTED.
               - FOR SORT ON A COLUMN   NA(I,KEYW) I=1,2,....,M
               + FOR SORT ON A ROW      NA(KEYW,J) J=1,2,....,N
    LOGICAL SORTS ONLY
    6  NSC     STARTING CHAR (1-10) IN KEYW. CHAR ARE LEFT TO RIGHT
    7  NCH     NUMBER OF CONSECUTIVE CHARACTERS TO BE SORTED.
    8  NSEQ    =0 FOR BINARY SORT
               =1 FOR ASCII SORT

OUTPUT
    1  NA      INPUT ARRAY SORTED AS DESIRED.

REMARKS
    1  THE ASCENDING ORDER OF SYMBOLS IS AS FOLLOWS.
                           : A B C D E F G H I J K L M N O P Q R S
                           T U V W X Y Z 0 1 2 3 4 5 6 7 8 9 + - *
                           / ( ) $ = BLANK , . # [ ] % " _ ! & ' ?
                           < > @ \ ^ ;

       ASCII SEQUENCE      BLANK ! " # $ % & ' ( ) * + , - . / 0 1
                           2 3 4 5 6 7 8 9 : ; < = > ? @ A B C D E
                           F G H I J K L M N O P Q R S T U V W X Y
                           Z [ \ ] ^ _

    2  THE WORD XSORTX MUST NOT BE USED. THIS IS A COMMON
       NAME USED FOR INTER ROUTINE COMMUNICATION.

    EXAMPLE...PERFORM A LOGICAL, ASCENDING SORT ON THE LAST 5
    CHARACTERS OF WORD 1 AND THE FIRST 2 CHARACTERS OF WORD 2
    ON THE FOLLOWING DATA STORED IN NA(I,J) I=1,7 AND J=1,3.

     PROGRAM MAIN
     DIMENSION NA(10,3)
         .
     CALL SORTLA(NA,10,7,5,-1,6,7,1)
         .
     END
  AAAAAAAAAA AA00012345 67890ABCDE
  AAAAAGAAAA AA00072345 67890ABCDE
  AAAAAFAAAA AB00062345 67890ABCDE
  AAAAAEAAAA AA00052345 67890ABCDE
  AAAAADAAAA AA00042345 67890ABCDE
  AAAAACAAAA AA00032345 67890ABCDE
  AAAAABAAAA AA00022345 67890ABCDE

  AFTER THE ABOVE SORT NA CONTAINS

  AAAAAAAAAA AA00012345 67890ABCDE
  AAAAABAAAA AA00022345 67890ABCDE
  AAAAACAAAA AA00032345 67890ABCDE
  AAAAADAAAA AA00042345 67890ABCDE
  AAAAAEAAAA AA00052345 67890ABCDE
  AAAAAFAAAA AB00062345 67890ABCDE
  AAAAAGAAAA AA00072345 67890ABCDE

REFERENCE
```

TABLE C-4. (Continued)

```
      SUBROUTINE SORT( NA, MRD, M, N, KEY, NSC, NCH, NSEQ )

      DIMENSION  NA(M ,N)
      LOGICAL  LREV, LLOG, KL, NL
      COMMON /XSORTY/ LLOG, MS,  MC,  MD,   NL,   IRD
      DATA NRR/0/
      ENTRY  SORTNA
      LREV = .FALSE.
      LLOG = .FALSE.
      JT = 3
      GO TO 5
      ENTRY  SORTND
      LREV = .TRUE.
      LLOG = .FALSE.
      JT = 4
      GO TO 5
      ENTRY  SORTLA
      LREV = .FALSE.
      JT = 1
      GO TO 4
      ENTRY  SORTLD
      LREV = .TRUE.
      JT = 2
    4 LLOG = .TRUE.
      MD = NSEQ
      MS = MAXO( 1, NSC )
      MC = NCH
    5 CONTINUE
      IRD = MRD
C
      KEY = IABS( KEYW )
      IF( KEY  ) 7, 7, 6
    6 KL = .TRUE.
      NL = .FALSE.
      NN = N
      MM = M
      GO TO 8
    7 KL = .FALSE.
      NL = .TRUE.
      NN = M
      MM = N
    8 CONTINUE
      NSTART = 1
      DO 200 J=2,NN
      K2 = J - 1
      JFST = 1
      LAST = K2
      IF( NL )  GO TO 65
      IF( KOMPARE( NA(KEY,J),NA(KEY,K2) )) 66, 200, 67
   65 IF( KOMPARE( NA(J,KEY),NA(K2,KEY) )) 66, 200, 67
C                 TRUE , FALSE
   66 IF( LREV )  200 ,  70
   67 IF( LREV )   70 ,  200
   70 IF( J-2 ) 170, 170, 100

  100 MID = ( JFST + LAST ) / 2
      IF( NL )  GO TO 105
      IF( KOMPARE( NA(KEY,J),NA(KEY,MID) )) 106, 140, 107
  105 IF( KOMPARE( NA(J,KEY),NA(MID,KEY) )) 106, 140, 107
C                 TRUE , FALSE
  106 IF( LREV )  140 ,  110
  107 IF( LREV )  110 ,  140
  110 IF( MID - LAST )  120, 130, 130
  120 LAST = MID
      GO TO 100
  130 NSTART = MID
      GO TO 170
  140 IF( JFST - MID )  150, 150, 160
  150 JFST = MID
      GO TO 100
  160 NSTART = MID + 1
  170 CONTINUE
      DO 195 K=1,MM
      IF( KL )  NHOLD = NA(K,J)
      IF( NL )  NHOLD = NA(J,K)
      K3 = J + 1
      DO 190 L=NSTART,K2
      K3 = K3 - 1
      IF( KL )  NA(K,K3) = NA(K,K3-1)
      IF( NL )  NA(K3,K) = NA(K3-1,K)
  190 CONTINUE
      IF( KL )  NA(K,K3-1) = NHOLD
      IF( NL )  NA(K3-1,K) = NHOLD
  195 CONTINUE
  200 CONTINUE
C
      DO 220 J=2,NN
      IF( NL )  GO TO 205
      IF( KOMPARE( NA(KEY,J),NA(KEY,J-1) )) 206, 220, 207
  205 IF( KOMPARE( NA(J,KEY), NA(J-1,KEY))) 206, 220, 207
  206 IF( LREV )  220 ,  210
  207 IF( LREV )  210 ,  220
  210 K1 = J
      NTRY = 1
      PRINT 902, NTRY, K1
  902 FORMAT(* SOMETHING WRONG WITH SORT --- NTRY =*I3,   K1 =*I4)
      RETURN
  220 CONTINUE
  300 RETURN
      END
```

TABLE C-4. (Concluded)

```
      FUNCTION  KOMPARE( N1 , N2 )
C     THIS FUNCTION IS CALLED BY SUBROUTINE SORT.
      COMMON /XSORTX/ LLOG, NSC, NCH, NSEQ, LORD, IRD
      DIMENSION  N1(1), N2(1)
      LOGICAL  LLOG, LORD
C
      IF( LLOG )  GO TO 100
      IF( N1(1) - N2(1) )  20, 30, 40
   20 NBRANCH = -1
      GO TO 50
   30 NBRANCH =  0
      GO TO 50
   40 NBRANCH = +1
   50 KOMPARE = NBRANCH
      RETURN
C
  100 IF( LORD )  GO TO 130
  110 KOMPARE = WTCOMP( NSC, N1    ,  NSC, N2    , NCH, NSEQ )
      RETURN
C
  130 J  = 1
      NC = 10
      JCH = NCH
      JSC = NSC
      IF( JSC - 1 )  140, 140, 150
  140 IF( JCH - 10)  110, 110, 170
  150 IF( JSC+JCH-11)110, 110, 200
  170 IF( WTCOMP( JSC, N1(J),  JSC,N2(J), NC, NSEQ ) ) 20, 180, 40
  180 JCH = JCH - 10
      JSC = MIN0( 1, JSC )
      J = J + IRD
  190 NC = MIN0( 10, JCH )
      IF( NC )  30, 30, 170
  200 NC = 11 - JSC
      JCH = JCH - NC + 10
      GO TO 170
      END
```

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APPENDIX D

EXAMPLE PROBLEMS

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Five example problems that have been aggregated by the computer code are included in this appendix. The examples were selected to present a representative coverage of many of the options available. All of the examples are for five judges ranking seven alternatives. The examples are briefly described as follows:

Example Problem Number 1: Aggregation of complete lists of unweighted projects.

Example Problem Number 2: Aggregation of incomplete project sublists which have been synthetically completed and multiplicatively weighted.

Example Problem Number 3: Aggregation of complete project sublists with multiplicative weights and judge self-evaluation ratings without a minimum self-rating threshold.

Example Problem Number 4: Aggregation of complete project sublists with multiplicative weights and judge self-evaluation ratings and with a 40 percent minimum self-rating threshold.

Example Problem Number 5: Aggregation of complete project and one requirements sublist, unweighted.

The input run control and data cards for all five example problems are listed in Table D-1. The key inputs are again listed at the beginning of each example problem output. Example Problems 1, 2, 3, 4, and 5, outputs are on Tables D-2, D-3, D-4, D-5, and D-6, respectively. The first pages of Table D-2 contain the Load Map for the computer code.

TABLE D-1.

```
EXAMPLE PROB NO 1. 5J X7A. COMPLETE, [illegible] WEIGHTS
    0    [illegible]    [illegible]    0    [illegible]    [illegible]    [illegible]
    [illegible]      PROJECTS
    1      PROJ A
    2      PROJ B
    3      PROJ C
    4      PROJ D
    5      PROJ E
    6      PROJ F
    7      PROJ G
           END
JUDGE 1
    1    2    [illegible]    4    [illegible]    [illegible]    [illegible]    .
JUDGE 2
    7    2   -4    3   -[illegible]    [illegible]    5    .
JUDGE 3
    [illegible]    4   -[illegible]    [illegible]   -[illegible]    1    2    .
JUDGE 4
    1    7    6   -2    [illegible]   -4    [illegible]    .
JUDGE 5
    4    3    2    1   -[illegible]    7    6    .
END
    [illegible]      END
EXAMPLE PROB NO 2. 5J X 7-INCOMPLETE.MULT WEIGHTS, SYS COMPLETION
    2    0    [illegible]    0    0    [illegible]    [illegible]
    2      PROJECTS
    1      PROJ A                      2
    2      PROJ B                      2
    [illegible]      PROJ C                      4
    4      PROJ D                      1
    [illegible]      PROJ E                      1
    6      PROJ F                      4
    7      PROJ G                      1
           END
JUDGE 1         [illegible]    1   1[illegible]
    1    2    3    4    [illegible]    6    7    .
JUDGE 2         3    1    [illegible]
    7    2   -4    1    6    5    .
JUDGE 3         3    4    4
    5    6   -[illegible]    .
JUDGE 4         [illegible]    2   1[illegible]
    1    7    6   -2    3   -4    5    .
JUDGE 5         3    1    [illegible]
    4    3    2    1   -[illegible]    7    6    .
END
    0      END
```

TABLE D-1. (Continued)

TABLE D-1. (Concluded)

```
EXAMPLE PROBLEM [illegible] COMPUTER/ REQUIREMENTS TRANSLATION
   [illegible]
   7     PROJECTS
   1     PRS -01
   2     PRS -02
   3     PRS -03
   4     PRS -04
   5     PRS -05
   6     PRS -06
   7     PRS -07
         END
JUDGE 1
   1   2   3   4   5   6   7   .
JUDGE 2
   7   2  -4   3  -1   4   5   .
JUDGE 3

   3   4  -5   6  -7   1   2   .
JUDGE 4
   1   7   6  -2   3  -4   5   .
END
  16     REQUIREMENTS
   1     R204.
   2     R301.
   3     R302.00[illegible]2
   4     R302.00[illegible]2
   5     R30[illegible].00[illegible]
   6     R304.
   7     R401.00A
   8     R401.00B
   9     R401.00C
  10     R401.00[illegible]
  11     R401.00I
  12     R401.00K
  13     R401.00N
  14     R601.
  15     R604.
  16     R606.
         END
JUDGE 5
   6  14   1   3   4   5  16   .
END
   0     END
```

TABLE D-2.

TECHNOLOGY PLANNING PRIORITIES   EXAMPLE PROB NO 1, 5J X7A, COMPLETE, NO WEIGHTS

NWT= 0   NPTYP1= 0   NPTYP2= 0   MATR= 0   THLD=0.00   NPRINT= 0

INPUT READ IN PROJECTS

INDEX	ELEMENT NAME	WT	CAT
1	PROJ A	0.	0
2	PROJ B	0.	0
3	PROJ C	0.	0
4	PROJ D	0.	0
5	PROJ E	0.	0
6	PROJ F	0.	0
7	PROJ G	0.	0
8	END	0.	0

TABLE D-2. (Continued)

```
EXAMPLE PROB NO 1, 5J X7A, COMPLETE, NO WEIGHTS

JUDGE 1        JCONV =   0    JUDGE WEIGHT =   0.0    JSE VALUE LIMIT =   0
TOTAL NBR ALT =   7      NR THIS JUDGE =   1

   1 >  2 >  3 =  4 >  5 >  6 >  7

JUDGE 2        JCONV =   0    JUDGE WEIGHT =   0.0    JSE VALUE LIMIT =   0
TOTAL NBR ALT =   7      NR THIS JUDGE =   2

   7 >  2 =  4 >  3 =  1 >  6 >  5

JUDGE 3        JCONV =   0    JUDGE WEIGHT =   0.0    JSE VALUE LIMIT =   0
TOTAL NBR ALT =   7      NR THIS JUDGE =   3

   3 >  4 =  5 >  6 =  7 >  1 >  2

JUDGE 4        JCONV =   0    JUDGE WEIGHT =   0.0    JSE VALUE LIMIT =   0
TOTAL NBR ALT =   7      NR THIS JUDGE =   4

   1 >  7 >  6 =  2 >  3 =  4 >  5

JUDGE 5        JCONV =   0    JUDGE WEIGHT =   0.0    JSE VALUE LIMIT =   0
TOTAL NBR ALT =   7      NR THIS JUDGE =   5

   4 >  3 >  2 >  1 =  5 >  7 >  6
```

TABLE D-2. (Continued)

SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 1, 5J X7A, COMPLETE, NO WEIGHTS

JUDGE 1 1 > 2 > 3 > 4 > 5 > 6 > 7

PROJ	1	2	3	4	5	6	7
1 I	0.0	1.0	1.0	1.0	1.0	1.0	1.0
2 I	0.0	0.0	1.0	1.0	1.0	1.0	1.0
3 I	0.0	0.	0.0	1.0	1.0	1.0	1.0
4 I	0.0	0.0	0.0	0.0	1.0	1.0	1.0
5 I	0.0	0.0	0.0	0.0	0.0	1.0	1.0
6 I	0.0	0.0	0.0	0.0	0.0	0.0	1.0
7 I	0.0	0.	0.0	0.0	0.0	0.0	0.0

TABLE D-2. (Continued)

SUB LIST FREQUENCY MATRIX — EXAMPLE PROB NO 1, 5J X7A, COMPLETE, NO WEIGHTS

JUDGE 2 — 7 > 2 = 4 > 3 = 1 > 6 > 5

PROJ	1	2	3	4	5	6	7
1 I	0.0	0.0	.5	0.0	1.0	1.0	0.0
2 I	1.0	0.0	1.0	.5	1.0	1.0	0.0
3 I	.5	[illegible]	[illegible]	0.0	1.0	1.0	0.0
4 I	1.0	.5	1.0	0.0	1.0	1.0	0.0
5 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 I	0.0	0.0	0.0	0.0	1.0	0.0	0.0
7 I	1.0	[illegible]	1.0	1.0	1.0	1.0	0.0

TABLE D-2. (Continued)

SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 1, 5J X7A, COMPLETE, NO WEIGHTS

JUDGE 3 3 > 4 = 5 > 6 = 7 > 1 > 2

PROJ	1	2	3	4	5	6	7
1 I	0.0	1.0	0.0	0.0	0.0	0.0	0.0
2 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 I	1.0	1.0	0.0	1.0	1.0	1.0	1.0
4 I	1.0	1.0	0.0	0.0	.5	1.0	1.0
5 I	1.0	1.	0.0	.5	0.0	1.0	1.0
6 I	1.0	1.0	0.0	0.0	0.0	0.0	.5
7 I	1.0	1.0	0.0	0.0	0.0	.5	0.0

TABLE D-2. (Continued)

SUB-LIST FREQUENCY MATRIX   EXAMPLE PROB NO 1, 5J X7A, COMPLETE, NO WEIGHTS

JUDGE 4   1 > 7 > 6 = 2 > 3 = 4 > 5

PROJ	1	2	3	4	5	6	7
1 I	0.0	1.	1.0	1.0	1.0	1.0	1.0
2 I	0.0	0.0	1.0	1.0	1.0	.5	0.0
3 I	0.0	0.0	0.0	.5	1.0	0.0	0.0
4 I	0.0	0.0	.5	0.0	1.0	0.0	0.0
5 I	0.0	0.	0.0	0.0	0.0	0.0	0.0
6 I	0.0	.5	1.0	1.0	1.0	0.0	0.0
7 I	0.0	1.0	1.0	1.0	1.0	1.0	0.0

TABLE D-2. (Continued)

SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 1, 5J X7A, COMPLETE, NO WEIGHTS

JUDGE 5 4 > 3 > 2 > 1 = 5 > 7 > 6

PROJ	1	2	3	4	5	6	7
1 I	0.0	0.	0.0	0.0	.5	1.0	1.0
2 I	1.0	0.0	0.0	0.0	1.0	1.0	1.0
3 I	1.0	1.0	0.0	0.0	1.0	1.0	1.0
4 I	1.0	1.0	1.0	0.0	1.0	1.0	1.0
5 I	.5	0.	0.0	0.0	0.0	1.0	1.0
6 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 I	0.0	0.0	0.0	0.0	0.0	1.0	0.0

TABLE D-2. (Continued)

```
SUMMED FREQUENCY MATRIX                  EXAMPLE PROB NO 1, 5J-X7A, COMPLETE, NO WEIGHTS

JUDGE INDIFFERENCE EXISTS

ADJ BORDA            1      2      3      4      5      6      7
                 ----------------------------------------------
     6.0   1 I      0.0    3.0    2.5    2.0    3.5    4.0    3.0
     4.0   2 I      2.0    0.0    3.0    2.5    4.0    3.5    2.0
     8.0   3 I      2.5    2.0    0.0    2.5    5.0    4.0    3.0
     9.0   4 I      3.0    2.5    2.5    0.0    4.5    4.0    3.0
   -12.0   5 I      1.5    1.0    0.0     .5    0.0    3.0    3.0
   -14.0   6 I      1.0    1.5    1.0    1.0    2.0    0.0    1.5
    -1.0   7 I      2.0    3.0    2.0    2.0    2.0    3.5    0.0

ADJ BORDA      4 >  3 >  1 >  2 >  7 >  5 >  6
```

TABLE D-2. (Continued)

COMPUTED PREFERENCE MATRIX EXAMPLE PROB NO 1, 5J X7A, COMPLETE, NO WEIGHTS

SUM		1	2	3	4	5	6	7
4.5	1 I	0.0	1.0	.5	0.0	1.0	1.0	1.0
3.5	2 I	0.0	0.0	1.0	.5	1.0	1.0	0.0
4.0	3 I	.5	0.0	0.0	.5	1.0	1.0	1.0
5.0	4 I	1.0	.5	.5	0.0	1.0	1.0	1.0
2.0	5 I	0.0	0.0	0.0	0.0	0.0	1.0	1.0
0.0	6 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.0	7 I	0.0	1.0	0.0	0.0	0.0	1.0	0.0

PREF 4 > 1 > 3 > 2 > 5 = 7 > 6

NUMBER OF FRACTIONAL SUMS= 2

LOWER N= 7 KENDALL D = 4.00 ZETA = .7143 PROB THAT RANK ORDER NOT CONSISTANT = .03335714

RANK ORDER CONSISTANT AT .05 LEVEL
RANK ORDER NOT CONSISTANT AT .01 LEVEL

UPPER N= 7 KENDALL D = 5.00 ZETA = .6429 PROB THAT RANK ORDER NOT CONSISTANT = .06900652

RANK ORDER NOT CONSISTANT AT .05 LEVEL
RANK ORDER NOT CONSISTANT AT .01 LEVEL

AVERAGE N= 7 KENDALL D = 4.50 ZETA = .6786 PROB THAT RANK ORDER NOT CONSISTANT = .05121429

RANK ORDER NOT CONSISTANT AT .05 LEVEL
RANK ORDER NOT CONSISTANT AT .01 LEVEL

TABLE D-2. (Continued)

NORMALIZED FREQUENCY MATRIX-FUZZY EXAMPLE PROB NO 1, 5J X7A, COMPLETE, NO WEIGHTS

	1	2	3	4	5	6	7
1 I	0.0	.6	.5	.4	.7	.8	.6
2 I	.4	0.	.6	.5	.8	.7	.4
3 I	.5	.4	0.0	.5	1.0	.8	.6
4 I	.6	.5	.5	0.0	.9	.8	.6
5 I	.3	.2	0.0	.1	0.0	.6	.6
6 I	.2	.3	.2	.2	.4	0.0	.3
7 I	.4	.5	.4	.4	.4	.7	0.0

F(R) = .407

C(R) = .593

PROJECT	1	2	3	4	5	6	7
FUZZY RANK	.80	.80	.80	1.00	0.00	.40	.60

FUZZY 4 > 2 = 3 = 1 = 7 > 6 > 5

TABLE D-2. (Continued)

```
CONCORDANCE SUMMARY BY ELEMENT                        EXAMPLE PROB NO 1, 5J X7A, COMPLETE, NO WEIGHTS
UNWEIGHTED SUBLISTS
                   1      2      3      4      5      6      7
JUDGE          ---------------------------------------------------
JUDGE 1      I    1.0    2.0    3.0    4.0    5.0    6.0    7.0
JUDGE 2      I    4.5    2.5    4.5    2.5    7.0    6.0    1.0
JUDGE 3      I    6.0    7.0    1.0    2.5    2.5    4.5    4.5
JUDGE 4      I    1.0    3.5    5.5    5.5    7.0    3.5    2.0
JUDGE 5      I    4.5    3.0    2.0    1.0    4.5    7.0    6.0
        ------ ---------------------------------------------------
R(J)             17.0   18.0   16.0   15.5   26.0   27.0   20.5

MEAN =       20.00      SUM OF DEVIATIONS SQUARED =    134.50

SUM T =        3.50

KENDALLS COEFICIENT OF CONCORDANCE =     .197     M =  5    N =  7

RANK ORDER NOT CONSISTANT AT  .05 LEVEL. CRITICAL S =  276.20
RANK ORDER NOT CONSISTANT AT  .01 LEVEL. CRITICAL S =  343.80
```

TABLE D-2. (Continued)

CONCORDANCE SUMMARY BY ELEMENT EXAMPLE PROB NO 1, 5J X7A, COMPLETE, NO WEIGHTS

UNWEIGHTED SUBLISTS

JUDGE		1	2	3	4	5	6	7
ADJ BORDA	I	3.0	4.0	2.0	1.0	6.0	7.0	5.0
PREF	I	2.0	4.0	3.0	1.0	5.5	7.0	5.5
R(J)		5.	8.	5.0	2.0	11.5	14.0	10.5

MEAN = 8.00 SUM OF DEVIATIONS SQUARED = 108.50

SUM T = .50

KENDALLS COEFICIENT OF CONCORDANCE = .977 M = 2 N = 7

RANK ORDER CONSISTANT AT .05 LEVEL. CRITICAL S = 97.00
RANK ORDER CONSISTANT AT .01 LEVEL. CRITICAL S = 104.00

TABLE D-2. (Continued)

```
CONCORDANCE SUMMARY BY ELEMENT                    EXAMPLE PROB NO 1, 5J X7A, COMPLETE, NO WEIGHTS
UNWEIGHTED SUBLISTS
                    1      2      3      4      5      6      7
JUDGE          ----------------------------------------
ADJ BORDA  I     3.0    4.0    2.0    1.0    6.0    7.0    5.0
FUZZY      I     3.5    3.5    3.5    1.0    7.0    6.0    3.5
------     ----------------------------------------
R(J)             6.5    7.5    5.5    2.0   13.0   13.0    8.5

MEAN =       8.00     SUM OF DEVIATIONS SQUARED =      95.00

SUM T =      5.00

KENDALLS COEFICIENT OF CONCORDANCE =      .931      M =  2      N =  7

RANK ORDER NOT CONSISTANT AT  .05 LEVEL. CRITICAL S =   97.00
RANK ORDER NOT CONSISTANT AT  .01 LEVEL. CRITICAL S =  104.00
```

TABLE D-2. (Continued)

CONCORDANCE SUMMARY BY ELEMENT   EXAMPLE PROB NO 1, 5J X7A, COMPLETE, NO WEIGHTS

UNWEIGHTED SUBLISTS

JUDGE		1	2	3	4	5	6	7
PREF	I	2.0	4.0	3.0	1.0	5.5	7.0	5.5
FUZZY	I	3.5	3.5	3.5	1.0	7.0	6.0	3.5
R(J)		5.5	7.5	6.5	2.0	12.5	13.0	9.0

MEAN = 8.00   SUM OF DEVIATIONS SQUARED = 91.00

SUM T = 5.50

KENDALLS COEFICIENT OF CONCORDANCE = .901   M = 2   N = 7

RANK ORDER NOT CONSISTANT AT .05 LEVEL. CRITICAL S = 97.33
RANK ORDER NOT CONSISTANT AT .01 LEVEL. CRITICAL S = 104.00

TABLE D-2. (Concluded)

EXAMPLE PROB NO 1, 5J X7A, COMPLETE, NO WEIGHTS

PREFERENCE RANK ORDER SUMMARY

ELEMENT INDEX RANK ORDER
4 > 1 > 3 > 2 > 5 = 7 > 6

RANK	PROJECT
1	PROJ D
2	PROJ A
3	PROJ C
4	PROJ B
5	PROJ E
5	PROJ G
6	PROJ F

TABLE D-3.

```
TECHNOLOGY PLANNING PRIORITIES          EXAMPLE PROB NO 2, 5J X 7A,INCOMPLETE,MULT WEIGHTS, SYN COMPLETION

NWT= 2   NPTYP1= 3   NPTYP2= 0   NATR= 0   THLD=0.00   NPRINT= 2

 INPUT READ IN PROJECTS

  INDEX     ELEMENT NAME                 WT          CAT

    1      PROJ A                        2.          0
    2      PROJ B                        2.          0
    3      PROJ C                        4.          0
    4      PROJ D                        1.          0
    5      PROJ E                        1.          0
    6      PROJ F                        4.          0
    7      PROJ G                        1.          0
    8      END                           0.          0
```

TABLE D-3. (Continued)

```
EXAMPLE PROB NO 2. 5J X 7A,INCOMPLETE,MULT WEIGHTS, SYN COMPLETION

JUDGE 1       JCONV =    3    JUDGE WEIGHT =   1.0    JSE VALUE LIMIT =   10
TOTAL NBR ALT =    7     NR THIS JUDGE =    1

   1 >  2 >  3 >  4 >  5 >  6 >  7

JUDGE 2       JCONV =    3    JUDGE WEIGHT =   1.0    JSE VALUE LIMIT =    5
TOTAL NBR ALT =    7     NR THIS JUDGE =    2

   7 >  2 =  4 >  1 >  6 >  5
SUBLIST IS INCOMPLETE

JUDGE 3       JCONV =    3    JUDGE WEIGHT =   4.0    JSE VALUE LIMIT =    4
TOTAL NBR ALT =    7     NR THIS JUDGE =    3

   5 >  6 =  7
SUBLIST IS INCOMPLETE

JUDGE 4       JCONV =    3    JUDGE WEIGHT =   2.0    JSE VALUE LIMIT =   10
TOTAL NBR ALT =    7     NR THIS JUDGE =    4

   1 >  7 >  6 =  2 >  3 =  4 >  5

JUDGE 5       JCONV =    3    JUDGE WEIGHT =   1.0    JSE VALUE LIMIT =    5
TOTAL NBR ALT =    7     NR THIS JUDGE =    5

   4 >  3 >  2 >  1 =  5 >  7 >  6
```

TABLE D-3. (Continued)

SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 2, 5J X 7A, INCOMPLETE, MULT WEIGHTS, SYN COMPLETION

JUDGE 1 - 1 > 2 > 3 > 4 > 5 > 6 > 7

PROJ		1	2	3	4	5	6	7
1	I	0.0	1.0	1.0	1.0	1.0	1.0	1.0
2	I	0.0	0.0	1.0	1.0	1.0	1.0	1.0
3	I	0.0	0.0	0.0	1.0	1.0	1.0	1.0
4	I	0.0	0.0	0.0	0.0	1.0	1.0	1.0
5	I	0.0	0.0	0.0	0.0	0.0	1.0	1.0
6	I	0.0	0.0	0.0	0.0	0.0	0.0	1.0
7	I	0.0	0.0	0.0	0.0	0.0	0.0	0.0

WEIGHTED SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 2, 5J X 7A, INCOMPLETE, MULT WEIGHTS, SYN COMPLETION

JUDGE 1

PROJ		1	2	3	4	5	6	7
1	I	0.0	8.0	8.0	8.0	8.0	8.0	8.0
2	I	0.0	0.0	8.0	8.0	8.0	8.0	8.0
3	I	0.0	0.0	0.0	16.0	16.0	16.0	16.0
4	I	0.0	0.0	0.0	0.0	4.0	4.0	4.0
5	I	0.0	0.0	0.0	0.0	0.0	4.0	4.0
6	I	0.0	0.0	0.0	0.0	0.0	0.0	16.0
7	I	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE D-3. (Continued)

SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 2, 5J X 7A, INCOMPLETE, MULT WEIGHTS, SYN COMPLETION

JUDGE 2 7 > 2 = 4 > 1 > 6 > 5 > 3

PROJ	1	2	3	4	5	6	7
1 I	0.0	0.0	1.0	0.0	1.0	1.0	0.0
2 I	1.0	0.0	1.0	.5	1.0	1.0	0.0
3 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 I	1.0	.5	1.0	0.0	1.0	1.0	0.0
5 I	0.0	0.	1.	0.0	0.0	0.0	0.0
6 I	0.0	0.0	1.0	0.0	1.0	0.0	0.0
7 I	1.0	1.0	1.0	1.0	1.0	1.0	0.0

WEIGHTED SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 2, 5J X 7A, INCOMPLETE, MULT WEIGHTS, SYN COMPLETION

JUDGE 2

PROJ	1	2	3	4	5	6	7
1 I	0.0	0.	8.	0.0	8.0	8.0	0.0
2 I	8.0	0.0	8.0	4.0	8.0	[illegible]	0.0
3 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 I	4.0	2.0	4.0	0.0	4.0	4.0	0.0
5 I	0.0	0.	4.	0.0	0.0	0.0	0.0
6 I	0.0	0.0	16.0	0.0	16.0	0.0	0.0
7 I	4.0	4.0	4.0	4.0	4.0	4.0	0.0

TABLE D-3. (Continued)

SUB-LIST FREQUENCY MATRIX   EXAMPLE PROB NO 2, 5J X 7A,INCOMPLETE,MULT WEIGHTS, SYN COMPLETION

JUDGE 3   5 > 6 = 7 > 1 = 2 = 3 = 4

PROJ	1	2	3	4	5	6	7
1 I	0.0	.5	.5	.5	0.0	0.0	0.0
2 I	.5	0.	.5	.5	0.0	0.0	0.0
3 I	.5	.5	0.0	.5	0.0	0.0	0.0
4 I	.5	.5	.5	0.0	0.0	0.0	0.0
5 I	1.0	1.0	1.0	1.0	0.0	1.0	1.0
6 I	1.0	1.0	1.0	1.0	0.0	0.0	.5
7 I	1.0	1.0	1.0	1.0	0.0	.5	0.0

WEIGHTED SUB-LIST FREQUENCY MATRIX   EXAMPLE PROB NO 2, 5J X 7A,INCOMPLETE,MULT WEIGHTS, SYN COMPLETION

JUDGE 3

PROJ	1	2	3	4	5	6	7
1 I	0.0	16.0	16.0	16.0	0.0	0.0	0.0
2 I	16.0	0.0	15.0	16.0	0.0	0.0	0.0
3 I	32.0	32.0	0.0	32.0	0.0	0.0	0.0
4 I	8.0	8.0	8.0	0.0	0.0	0.0	0.0
5 I	16.0	16.0	15.0	16.0	0.0	16.0	16.0
6 I	64.0	64.0	64.0	64.0	0.0	0.0	32.0
7 I	16.0	16.	15.0	16.0	0.0	8.0	0.0

TABLE D-3. (Continued)

SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 2, 5J X 7A, INCOMPLETE, MULT WEIGHTS, SYN COMPLETION

JUDGE 4 1 > 7 > 6 = 2 > 3 = 4 > 5

PROJ	1	2	3	4	5	6	7
1 I	0.0	1.0	1.0	1.0	1.0	1.0	1.0
2 I	0.0	0.0	1.0	1.0	1.0	.5	0.0
3 I	0.0	0.0	0.0	.5	1.0	0.0	0.0
4 I	0.0	0.0	.5	0.0	1.0	0.0	0.0
5 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 I	0.0	.5	1.0	1.0	1.0	0.0	0.0
7 I	0.0	1.	1.0	1.0	1.0	1.0	0.0

WEIGHTED SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 2, 5J X 7A, INCOMPLETE, MULT WEIGHTS, SYN COMPLETION

JUDGE 4

PROJ	1	2	3	4	5	6	7
1 I	0.0	16.0	16.0	16.0	16.0	16.0	16.0
2 I	0.0	0.0	16.0	16.0	16.0	8.0	0.0
3 I	0.0	0.0	8.0	16.0	32.0	0.0	0.0
4 I	0.0	0.0	4.0	0.0	8.0	0.0	0.0
5 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 I	0.0	16.0	32.0	32.0	32.0	0.0	0.0
7 I	0.0	8.	8.0	8.0	8.0	8.0	0.0

TABLE D-3. (Continued)

SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 2, 5J X 7A,INCOMPLETE,MULT WEIGHTS, SYN COMPLETION

JUDGE 5 4 > 3 > 2 > 1 = 5 > 7 > 6

PROJ	1	2	3	4	5	6	7
1 I	0.0	0.0	0.0	0.0	.5	1.0	1.0
2 I	1.0	0.0	0.0	0.0	1.0	1.0	1.0
3 I	1.0	1.	0.0	0.0	1.0	1.0	1.0
4 I	1.0	1.0	1.0	0.0	1.0	1.0	1.0
5 I	.5	0.0	0.0	0.0	0.0	1.0	1.0
6 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 I	0.0	0.	0.	0.0	0.0	1.0	0.0

WEIGHTED SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 2, 5J X 7A,INCOMPLETE,MULT WEIGHTS, SYN COMPLETION

JUDGE 5

PROJ	1	2	3	4	5	6	7
1 I	0.0	0.0	0.0	0.0	4.0	8.0	8.0
2 I	8.0	0.0	0.0	0.0	8.0	8.0	8.0
3 I	16.0	16.	0.0	0.0	16.0	16.0	16.0
4 I	4.0	4.0	4.0	0.0	4.0	4.0	4.0
5 I	2.0	0.0	0.0	0.0	0.0	4.0	4.0
6 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 I	0.0	0.	0.	0.0	0.0	4.0	0.0

TABLE D-3. (Continued)

SUMMED FREQUENCY MATRIX EXAMPLE PROB-NO 2, 5J X 7A, INCOMPLETE, MULT WEIGHTS. SYN COMPLETION

JUDGE INDIFFERENCE EXISTS

EQUIV ADJ BORDA	ADJ BORDA		1	2	3	4	5	6	7
38.0	9.5	1 I	0.0	40.0	48.0	40.0	36.0	40.0	32.0
-14.0	-3.5	2 I	32.0	0.0	48.0	44.0	40.0	32.0	16.0
12.0	3.0	3 I	48.0	48.0	0.0	64.0	64.0	32.0	32.0
-198.0	-49.5	4 I	16.0	14.0	20.0	0.0	28.0	12.0	8.0
-102.0	-25.5	5 I	18.0	16.0	20.0	16.0	0.0	24.0	24.0
284.0	71.0	6 I	64.0	80.0	112.0	96.0	48.0	0.0	48.0
-20.0	-5.0	7 I	20.0	28.0	28.0	28.0	12.0	24.0	0.0

ADJ BORDA 6 > 1 > 3 > 2 > 7 > 5 > 4

TABLE D-3. (Continued)

OMPUTED PREFERENCE MATRIX EXAMPLE PROB NO 2, 5J X 7A,INCOMPLETE,MULT WEIGHTS, SYN COMPLETION

SUM		1	2	3	4	5	6	7
4.5	1 I	0.0	1.0	.5	1.0	1.0	0.0	1.0
2.5	2 I	0.0	0.0	.5	1.0	1.0	0.0	0.0
4.0	3 I	.5	.5	0.0	1.0	1.0	0.0	1.0
1.0	4 I	0.0	0.0	0.0	0.0	1.0	0.0	0.0
1.0	5 I	0.0	0.0	0.0	0.0	0.0	0.0	1.0
6.0	6 I	1.0	1.0	1.0	1.0	1.0	0.0	1.0
2.0	7 I	0.0	1.0	0.0	1.0	0.0	0.0	0.0

REF 6 > 1 > 3 > 2 > 7 > 4 = 5

UMBER OF FRACTIONAL SUMS= 2

OWER N= 7 KENDALL D = 2.00 ETA = .8571 PROB THAT RANK ORDER NOT CONSISTANT = .00613289

ANK ORDER CONSISTANT AT .05 LEVEL
ANK ORDER CONSISTANT AT .01 LEVEL

PPER N= 7 KENDALL D = 4.00 ZETA = .7143 PROB THAT RANK ORDER NOT CONSISTANT = .03335714

ANK ORDER CONSISTANT AT .05 LEVEL
ANK ORDER NOT CONSISTANT AT .01 LEVEL

VERAGE N= 7 KENDALL D = 3.00 ZETA = .7857 PROB THAT RANK ORDER NOT CONSISTANT = .01728571

ANK ORDER CONSISTANT AT .05 LEVEL
ANK ORDER NOT CONSISTANT AT .01 LEVEL

TABLE D-3. (Continued)

CONCORDANCE SUMMARY BY ELEMENT EXAMPLE PROB-NO 2, 5J X 7A,INCOMPLETE,MULT WEIGHTS, SYN COMPLETION

UNWEIGHTED SUBLISTS

JUDGE		1	2	3	4	5	6	7
JUDGE 1	I	1.0	2.0	3.0	4.0	5.0	6.0	7.0
JUDGE 2	I	4.0	2.5	7.0	2.5	6.0	5.0	1.0
JUDGE 3	I	5.5	5.5	5.5	5.5	1.0	2.5	2.5
JUDGE 4	I	1.0	3.5	5.5	5.5	7.0	3.5	2.0
JUDGE 5	I	4.5	3.0	2.0	1.0	4.5	7.0	6.0
R(J)		16.0	15.5	23.0	18.5	23.5	24.0	19.5

MEAN = 20.00 SUM OF DEVIATIONS SQUARED = 70.00

SUM T = 7.50

KENDALLS COEFICIENT OF CONCORDANCE = .166 M = 5 N = 7

RANK ORDER NOT CONSISTANT AT .05 LEVEL. CRITICAL S = 276.20
RANK ORDER NOT CONSISTANT AT .01 LEVEL. CRITICAL S = 343.80

TABLE D-3. (Continued)

```
CONCORDANCE SUMMARY BY ELEMENT                          EXAMPLE PROB NO 2, 5J X 7A,INCOMPLETE,MULT WEIGHTS, SYN COMPLETION
UNWEIGHTED SUBLISTS
                   1      2      3      4      5      6      7
JUDGE           -----------------------------------------------
ADJ BORDA       I    2.0    4.0    3.0    7.0    6.0    1.0    5.0
PREF            I    2.0    4.0    3.0    6.5    6.5    1.0    5.0
       ------   -----------------------------------------------
R(J)                 4.0    8.0    6.0   13.5   12.5    2.0   10.0

MEAN =        8.00      SUM OF DEVIATIONS SQUARED =     110.50

SUM T =        .50

KENDALLS COEFICIENT OF CONCORDANCE =       .995     M =  2      N =  7

RANK ORDER      CONSISTANT AT  .05 LEVEL. CRITICAL S =    97.00
RANK ORDER      CONSISTANT AT  .01 LEVEL. CRITICAL S =   104.00
```

TABLE D-3. (Concluded)

EXAMPLE PROB NO 2, 5J X 7A, INCOMPLETE, MULT WEIGHTS, SYN COMPLETION

PREFERENCE RANK ORDER SUMMARY

ELEMENT INDEX RANK ORDER
6 > 1 > 3 > 2 > 7 > 4 = 5

RANK	PROJECT
1	PROJ F
2	PROJ A
3	PROJ C
4	PROJ B
5	PROJ G
6	PROJ D
6	PROJ E

TABLE D-4.

TECHNOLOGY PLANNING PRIORITIES EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT WTS

NWT= 2 NPTYP1= 3 NPTYP2= 0 MATR= 1 THLD=0.00 NPRINT= 0

INPUT READ IN PROJECTS

INDEX	ELEMENT NAME	WT	CAT
1	PROJ A	2.	0
2	PROJ B	2.	0
3	PROJ C	4.	0
4	PROJ D	1.	0
5	PROJ E	1.	0
6	PROJ F	4.	0
7	PROJ G	1.	0
0	END	0.	0

TABLE D-4. (Continued)

```
-EXAMPLE PROB NO 3. SJ < 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT WTS

JUDGE 1      JCONV =          JUDGE WEIGHT =  1.0   JSE VALUE LIMIT =  10
TOTAL NBR ALT =   7     NR THIS JUDGE =   1

  1 > 2 > 3 > 4 > 5 > 6 > 7

 .20    .40    .40    .60    .20    1.05    .40

JUDGE 2      JCONV =   0   JUDGE WEIGHT =  1.0   JSE VALUE LIMIT =   9
TOTAL NBR ALT =   7     NR THIS JUDGE =   2

  7 > 2 = 4 > 3 > 1 > 6 > 5

 .20    .40    .40    .40    .20    1.00    .90

JUDGE 3      JCONV =   0   JUDGE WEIGHT =  4.0   JSE VALUE LIMIT =   6
TOTAL NBR ALT =   7     NR THIS JUDGE =   3

  3 > 4 = 5 > 6 = 7 > 1 > 2

 1.00    .75    1.33    1.00    .75    1.00    .50

JUDGE 4      JCONV =   0   JUDGE WEIGHT =  2.0   JSE VALUE LIMIT =  10
TOTAL NBR ALT =   7     NR THIS JUDGE =   4

  1 > 7 > 5 = 2 > 3 > 4 > 6

 .60    .50    .75    1.00    1.00    .50    .40

JUDGE 5      JCONV =   0   JUDGE WEIGHT =  1.0   JSE VALUE LIMIT =   5
TOTAL NBR ALT =   7     NR THIS JUDGE =   5

  4 > 3 > 2 > 1 > 5 > 7 > 6

 1.00    1.00    .40    1.00    .20    .00    1.00
```

TABLE D-4. (Continued)

SUB-LIST FREQUENCY MATRIX   EXAMPLE PROB NO 3. 5J X 7A.COMPLETE.JUDGE SELF EVAL (W/O THLD).MULT WTS

JUDGE 1   1 > 2 > 3 > 4 > 5 > 6 > 7

PROJ	1	2	3	4	5	6	7
1 I	[illegible]	[illegible]	1.0	1.0	1.0	1.0	1.0
2 I	0.0	0.0	1.0	1.0	1.0	1.0	1.0
3 I	0.0	0.0	0.0	1.0	1.0	1.0	1.0
4 I	0.0	0.0	0.0	0.0	1.0	1.0	1.0
5 I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.0
6 I	0.0	0.0	0.0	0.0	0.0	0.0	1.0
7 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SUB-LIST SELF EVALUATION FREQUENCY MATRIX   EXAMPLE PROB NO 3. 5J X 7A.COMPLETE.JUDGE SELF EVAL (W/O THLD).MULT WTS

JUDGE 1   1 > 2 > 3 > 4 > 5 > 6 > 7

PROJ	1	2	3	4	5	6	7
1 I	[illegible]	.2	.20	.20	.20	.20	.20
2 I	0.00	0.00	.80	.80	.80	.80	.80
3 I	0.00	0.00	0.00	.40	.40	.40	.40
4 I	0.00	0.00	0.00	0.00	.60	.60	.60
5 I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.20	.20
6 I	0.00	0.00	0.00	0.00	0.00	0.00	1.00
7 I	0.00	0.00	0.00	0.00	0.00	0.00	0.00

WEIGHTED SUB-LIST FREQUENCY MATRIX   EXAMPLE PROB NO 3. 5J X 7A.COMPLETE.JUDGE SELF EVAL (W/) THLD).MULT WTS

JUDGE 1

PROJ	1	2	3	4	5	6	7
1 I	[illegible]	1.6	1.6	1.6	1.6	1.6	1.6
2 I	0.0	0.0	5.4	5.4	6.4	6.4	6.4
3 I	0.0	0.0	0.0	6.4	6.4	6.4	6.4
4 I	0.0	0.0	0.0	0.0	2.4	2.4	2.4
5 I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.9	.8
6 I	0.0	0.0	0.0	0.0	0.0	0.0	16.0
7 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE D-4. (Continued)

SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT WTS

JUDGE 2 7 > 2 = 4 > 3 = 1 > 6 > 5

PROJ	1	2	3	4	5	6	7
1 I	[illegible]	[illegible]	.5	0.0	1.0	1.0	0.0
2 I	1.0	0.0	1.0	.5	1.0	1.0	0.0
3 I	.5	0.0	0.0	0.0	1.0	1.0	0.0
4 I	1.0	.5	1.0	0.0	1.0	1.0	0.0
5 I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6 I	0.0	0.0	0.0	0.0	1.0	0.0	0.0
7 I	1.0	1.0	1.0	1.0	1.0	1.0	0.0

SUB-LIST SELF EVALUATION FREQUENCY MATRIX EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT WTS

JUDGE 2 7 > 2 = 4 > 3 = 1 > 6 > 5

PROJ	1	2	3	4	5	6	7
1 I	0.00	0.00	.10	0.00	.20	.20	0.00
2 I	.40	0.00	.40	.20	.40	.40	0.00
3 I	.20	0.00	0.00	0.00	.40	.40	0.00
4 I	.40	.20	.40	0.00	.40	.40	0.00
5 I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.00	0.00
6 I	0.00	0.00	0.00	0.00	1.00	0.00	0.00
7 I	.80	.80	.80	.80	.80	.80	0.00

WEIGHTED SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT WTS

JUDGE 2

PROJ	1	2	3	4	5	6	7
1 I	[illegible]	[illegible]	.8	[illegible]	1.6	1.6	[illegible]
2 I	3.2	0.0	3.2	1.6	3.2	3.2	0.0
3 I	3.2	0.0	0.0	0.0	6.4	6.4	0.0
4 I	1.6	.8	1.6	0.0	1.6	1.6	0.0
5 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 I	[illegible]	0.0	0.0	0.0	10.0	0.0	0.0
7 I	3.2	3.2	3.2	3.2	3.2	3.2	0.0

TABLE D-4. (Continued)

SUB-LIST FREQUENCY MATRIX   EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT WTS

JUDGE 3   3 > 4 = 5 > 6 = 7 > 1 > 2

PROJ	1	2	3	4	5	6	7
1 I	0.0	1.0	0.0	0.0	0.0	0.0	0.0
2 I	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
3 I	1.0	1.0	0.0	1.0	1.0	1.0	1.0
4 I	1.0	1.0	0.0	0.0	.5	1.0	1.0
5 I	1.0	1.0	0.0	.5	0.0	1.0	1.0
6 I	1.0	1.0	0.0	0.0	0.0	0.0	.5
7 I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.5	0.0

SUB-LIST SELF EVALUATION FREQUENCY MATRIX   EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT WTS

JUDGE 3   3 > 4 = 5 > 6 = 7 > 1 > 2

PROJ	1	2	3	4	5	6	7
1 I	0.00	1.00	0.00	0.00	0.00	0.00	0.00
2 I	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 I	1.00	1.0	[illegible]	1.00	1.00	1.00	1.00
4 I	1.00	1.00	0.00	0.00	.50	1.00	1.00
5 I	.75	.75	0.00	.38	0.00	.75	.75
6 I	1.00	1.00	0.00	0.00	0.00	0.00	.50
7 I	.50	.5	[illegible]	[illegible]	[illegible]	.25	0.00

WEIGHTED SUB-LIST FREQUENCY MATRIX   EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT WTS

JUDGE 3

PROJ	1	2	3	4	5	6	7
1 I	0.0	32.0	0.0	0.0	0.0	0.0	0.0
2 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 I	64.0	64.0	[illegible]	64.0	64.0	64.0	64.0
4 I	16.0	16.0	0.0	0.0	8.0	16.0	16.0
5 I	12.0	12.0	0.0	6.0	0.0	12.0	12.0
6 I	64.0	64.0	0.0	0.0	0.0	0.0	32.0
7 I	8.0	8.0	0.0	0.0	[illegible]	4.0	[illegible]

TABLE D-4. (Continued)

SUB-LIST FREQUENCY MATRIX   EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT WTS

JUDGE 4   1 > 7 > 6 = 2 > 3 = 4 > 5

PROJ	1	2	3	4	5	6	7
1 I	0.0	1.0	1.0	1.0	1.0	1.0	1.0
2 I	0.0	0.0	1.0	1.0	1.0	.5	0.0
3 I	0.0	0.0	0.0	.5	1.0	0.0	0.0
4 I	0.0	0.0	.5	0.0	1.0	0.0	0.0
5 I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.0
6 I	0.0	.5	1.0	1.0	1.0	0.0	0.0
7 I	0.0	1.0	1.0	1.0	1.0	1.0	0.0

SUB-LIST SELF EVALUATION FREQUENCY MATRIX   EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT WTS

JUDGE 4   1 > 7 > 6 = 2 > 3 = 4 > 5

PROJ	1	2	3	4	5	6	7
1 I	0.00	.6	.60	.60	.60	.60	.60
2 I	0.00	0.00	.50	.50	.50	.25	0.00
3 I	0.00	0.00	0.00	.35	.70	0.00	0.00
4 I	0.00	0.00	.50	0.00	1.00	0.00	0.00
5 I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6 I	0.00	.30	.60	.60	.60	0.00	0.00
7 I	0.00	[illegible]	[illegible]	.80	.80	.80	0.00

WEIGHTED SUB-LIST FREQUENCY MATRIX   EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT WTS

JUDGE 4

PROJ	1	2	3	4	5	6	7
1 I	[illegible]	9.6	9.6	9.6	9.6	9.6	9.6
2 I	0.0	0.0	8.0	8.0	8.0	4.0	0.0
3 I	0.0	0.0	0.0	11.2	22.4	0.0	0.0
4 I	0.0	0.0	4.0	0.0	8.0	0.0	0.0
5 I	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
6 I	0.0	9.6	19.2	19.2	19.2	0.0	0.0
7 I	0.0	6.4	6.4	6.4	6.4	6.4	0.0

TABLE D-4. (Continued)

SUB-LIST FREQUENCY MATRIX   EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT WTS

JUDGE 5   4 > 3 > 2 > 1 = 5 > 7 > 6

PROJ	1	2	3	4	5	6	7
1 I	0.0	0.0	0.0	0.0	.5	1.0	1.0
2 I	1.0	0.0	0.0	0.0	1.0	1.0	1.0
3 I	1.0	1.0	0.0	0.0	1.0	1.0	1.0
4 I	1.0	1.0	1.0	0.0	1.0	1.0	1.0
5 I	.5	0.0	0.0	0.0	0.0	1.0	1.0
6 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.0	0.0

SUB-LIST SELF EVALUATION FREQUENCY MATRIX   EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT WTS

JUDGE 5   4 > 3 > 2 > 1 = 5 > 7 > 6

PROJ	1	2	3	4	5	6	7
1 I	0.00	0.00	0.00	0.00	.50	1.00	1.00
2 I	1.00	0.00	0.00	0.00	1.00	1.00	1.00
3 I	.80	.8	0.0	0.00	.80	.80	.80
4 I	1.00	1.00	1.00	0.00	1.00	1.00	1.00
5 I	.10	0.00	0.00	0.00	0.00	.20	.20
6 I	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7 I	0.00	0.0	0.0	0.00	0.00	1.00	0.00

WEIGHTED SUB-LIST FREQUENCY MATRIX   EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT WTS

JUDGE 5

PROJ	1	2	3	4	5	6	7
1 I	0.0	0.0	0.0	0.0	4.0	8.0	8.0
2 I	8.0	0.0	0.0	0.0	8.0	8.0	8.0
3 I	12.8	12.8	[illegible]	0.0	12.8	12.8	12.8
4 I	4.0	4.0	4.0	0.0	4.0	4.0	4.0
5 I	.4	0.0	0.0	0.0	0.0	.8	.8
6 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 I	0.0	0.0	0.0	0.0	0.0	4.0	0.0

TABLE D-4. (Continued)

SUMMED FREQUENCY MATRIX   EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT W

JUDGE INDIFFERENCE EXISTS

EQUIV ADJ BORDA	ADJ BORDA		1	2	3	4	5	6	7
-77.2	-19.3	1 I	0.0	43.2	12.0	11.2	16.6	20.8	19.2
-137.6	-34.4	2 I	11.2	0.0	17.6	16.0	25.6	21.6	14.4
455.2	113.8	3 I	[illegible]	76.8	0.0	81.6	[illegible]	89.6	83.2
-21.2	-5.3	4 I	21.6	20.8	9.6	0.0	24.8	24.0	22.4
-165.6	-41.4	5 I	12.4	12.0	0.0	6.0	0.0	13.6	13.6
72.0	18.0	6 I	64.0	73.6	19.2	19.2	35.2	0.0	48.0
-125.6	-31.4	7 I	11.2	17.6	9.6	9.6	9.6	17.6	0.0

ADJ BORDA   3 > 6 > 4 > 1 > 7 > 2 > 5

TABLE D-4. (Continued)

COMPUTED PREFERENCE MATRIX EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT WTS

SUM		1	2	3	4	5	6	7
3.0	1 I	0.0	1.0	0.0	0.0	1.0	0.0	1.0
1.0	2 I	0.0	0.0	0.0	0.0	1.0	0.0	0.0
6.0	3 I	1.0	1.0	0.0	1.0	1.0	1.0	1.0
5.0	4 I	1.0	1.0	0.0	0.0	1.0	1.0	1.0
1.0	5 I	0.0	0.0	0.0	0.0	0.0	0.0	1.0
4.0	6 I	1.0	1.0	0.0	0.0	1.0	0.0	1.0
1.0	7 I	0.0	1.0	0.0	0.0	0.0	0.0	0.0

PREF 3 > 4 > 6 > 1 > 5 = 2 = 7

NUMBER OF FRACTIONAL SUMS= 0

N= 7 KENDALL D = 1.00 ZETA = .9286 PROB THAT RANK ORDER NOT CONSISTANT = .0020241

RANK ORDER CONSISTANT AT .05 LEVEL
RANK ORDER CONSISTANT AT .01 LEVEL

TABLE D-4. (Continued)

CONCORDANCE SUMMARY BY ELEMENT   EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT W

UNWEIGHTED SUBLISTS

JUDGE		1	2	3	4	5	6	7
JUDGE 1	I	1.0	2.0	3.0	4.0	5.0	6.0	7.0
JUDGE 2	I	4.5	2.5	4.5	2.5	7.0	6.0	1.0
JUDGE 3	I	6.0	7.0	1.0	2.5	2.5	4.5	4.5
JUDGE 4	I	1.0	3.5	5.5	5.5	7.0	3.5	2.0
JUDGE 5	I	4.5	3.0	2.0	1.0	4.5	7.0	6.0
R(J)		17.	18.0	16.0	15.5	26.0	27.0	20.5

MEAN = 20.00   SUM OF DEVIATIONS SQUARED = 134.50

SUM T = 3.50

KENDALLS COEFICIENT OF CONCORDANCE = .197   N = 5   N = 7

RANK ORDER NOT CONSISTANT AT .05 LEVEL. CRITICAL S = 276.28
RANK ORDER NOT CONSISTANT AT .01 LEVEL. CRITICAL S = 343.80

TABLE D-4. (Continued)

CONCORDANCE SUMMARY BY ELEMENT EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT

UNWEIGHTED SUBLISTS

JUDGE		1	2	3	4	5	6	7
~~ADJ BORDA~~	~~I~~	~~4.0~~	~~6.0~~	~~1.0~~	~~3.0~~	~~7.0~~	~~2.0~~	~~5.0~~
PREF	I	4.0	5.0	1.0	2.0	6.0	3.0	6.0
R(J)		8.0	12.0	2.0	5.0	13.0	5.0	11.0

MEAN = 8.00 SUM OF DEVIATIONS SQUARED = 104.00

SUM T = 2.00

KENDALLS COEFICIENT OF CONCORDANCE = .963 M = 2 N = 7

RANK ORDER CONSISTANT AT .05 LEVEL. CRITICAL S = 97.00

~~RANK ORDER~~ NOT CONSISTANT AT .01 ~~LEVEL. CRITICAL S = 104.00~~

TABLE D-4. (Concluded)

EXAMPLE PROB NO 3, 5J X 7A,COMPLETE,JUDGE SELF EVAL (W/O THLD),MULT WTS

PREFERENCE RANK ORDER SUMMARY

ELEMENT INDEX RANK ORDER
3 > 4 > 6 > 1 > 5 = 2 = 7

RANK	PROJECT
1	PROJ C
2	PROJ D
3	PROJ F
4	PROJ A
5	PROJ E
5	PROJ B
5	PROJ G

TABLE D-5.

TECHNOLOGY PLANNING PRIORITIES   EXAMPLE PROB NO 4, 5J X7A, COMPLETE,JUDGE SELF EVAL(40% THLD),MULT WTS

NWT= 2 NPTYP1= 0 NPTYP2= 6 MATR= 2 THLD= .40 NPRINT= 0

INPUT READ IN PROJECTS

INDEX	ELEMENT NAME	WT	CAT
1	PROJ A	2.	0
2	PROJ B	2.	0
3	PROJ C	4.	0
4	PROJ D	1	0
5	PROJ E	1.	0
6	PROJ F	4.	0
7	PROJ G	1.	0
0	END	0.	0

TABLE D-5. (Continued)

```
EXAMPLE PROB NO 4, 5J V7A, COMPLETE,JUDGE SELF EVAL(40% THLD),MULT WTS


JUDGE 1        JCONV =     0    JUDGE WEIGHT =   1.0    JSE VALUE LIMIT =   10
TOTAL NBR ALT =    7      NR THIS JUDGE =    1

   1 >  2 >  3 >  4 >  5 >  6 >  7

  .20      .50      .40      .60      .20     1.00      .40

JUDGE 2        JCONV =     0    JUDGE WEIGHT =   1.0    JSE VALUE LIMIT =    5
TOTAL NBR ALT =    7      NR THIS JUDGE =    2

   7 >  2 =  4 >  3 =  1 >  6 >  5

  .20      .40      .40      .40      .20     1.00      .50

JUDGE 3        JCONV =     0    JUDGE WEIGHT =   4.0    JSE VALUE LIMIT =    4
TOTAL NBR ALT =    7      NR THIS JUDGE =    3

   3 >  4 =  5 >  6 =  7 >  1 >  2

 1.00      .75     1.00     1.00      .75     1.00      .52

JUDGE 4        JCONV =     0    JUDGE WEIGHT =   2.0    JSE VALUE LIMIT =   10
TOTAL NBR ALT =    7      NR THIS JUDGE =    4

   1 >  7 >  6 =  2 >  3 =  4 >  5

  .50      .50      .70     1.00     1.00      .60      .80
```

TABLE D-5. (Continued)

JUDGE 5 JCONV = 0 JUDGE WEIGHT = 1.0 USE VALUE LIMIT = 5

TOTAL NBR ALT = 7 NR THIS JUDGE = 5

4 > 3 > 2 > 1 = 5 > 7 > 6

1.00 1.00 .90 1.00 .20 .80 1.00

SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 4, 5J X7A, COMPLETE,JUDGE SELF EVAL(40% THLD),MULT

JUDGE 1 2 > 4 > 6 > 7

PROJ	1	2	3	4	5	6	7
1 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 I	0.0	0.0	0.0	1.0	0.0	1.0	1.0
3 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 I	0.0	0.0	0.0	0.0	0.0	1.0	1.0
5 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 I	0.0	0.0	0.0	0.0	0.0	0.0	1.0
7 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE D-5. (Continued)

SUB-LIST SELF EVALUATION FREQUENCY MATRIX   EXAMPLE PROB NO 4, 5J X7A, COMPLETE,JUDGE SELF EVAL(40% THLD),MUL

JUDGE 1   2 > 4 > 6 > 7 = 0 > 0 > 0

REDUCED MATRIX

PROJ	1	2	3	4	5	6	7
1 I	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 I	0.00	0.00	0.00	.80	0.00	.80	.80
3 I	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 I	0.00	0.00	0.00	0.00	0.00	.60	.60
5 I	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6 I	0.00	0.00	0.00	0.00	0.00	0.00	1.00
7 I	0.00	0.00	0.00	0.00	0.00	0.00	0.00

WEIGHTED SUB-LIST FREQUENCY MATRIX   EXAMPLE PROB NO 4, 5J X7A, COMPLETE,JUDGE SELF EVAL(40% THLD),MULT WTS

JUDGE 1

PROJ	1	2	3	4	5	6	7
1 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 I	0.0	0.0	0.0	6.4	0.0	6.4	6.4
3 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 I	0.0	0.0	0.0	0.0	0.0	2.4	2.4
5 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 I	0.0	0.0	0.0	0.0	0.0	0.0	16.0
7 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE D-5. (Continued)

SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 4, 5J X7A, COMPLETE,JUDGE SELF EVAL(40% THLD),MULT WTS

JUDGE 2 6 > 5

PROJ	1	2	3	4	5	6	7
1 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 I	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0
4 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 I	0.0	0.0	0.0	0.0	1.0	0.0	0.0
7 I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.0

SUB-LIST SELF EVALUATION FREQUENCY MATRIX EXAMPLE PROB NO 4, 5J X7A, COMPLETE,JUDGE SELF EVAL(40% THLD),MULT WTS

JUDGE 2 6 > 5 > 0 > 0 = 0 > 0 > 0

REDUCED MATRIX

PROJ	1	2	3	4	5	6	7
1 I	[illegible]	0.0	[illegible]	0.00	0.00	0.00	0.00
2 I	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 I	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 I	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6 I	0.00	0.00	0.00	0.00	1.00	0.00	0.00
7 I	0.00	0.00	0.00	0.00	0.00	0.00	0.00

WEIGHTED SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 4, 5J X7A, COMPLETE,JUDGE SELF EVAL(40% THLD),MULT WTS

JUDGE 2

PROJ	1	2	3	4	5	6	7
1 I	0.0	0.0	0.	[illegible]	[illegible]	[illegible]	[illegible]
2 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 I	[illegible]	[illegible]	[illegible]	[illegible]	16.[illegible]	0.0	0.0
7 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE D-5. (Continued)

SUB-LIST FREQUENCY MATRIX   EXAMPLE PROB NO 4, 5J X7A, COMPLETE,JUDGE SELF EVAL(40% THLD),MULT WTS

JUDGE 3   3 > 4 = 5 > 6 = 7 > 1 > 2

PROJ	1	2	3	4	5	6	7
1 I	0.0	1.0	0.0	0.0	0.0	0.0	0.0
2 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 I	1.0	1.0	0.0	1.0	1.0	1.0	1.0
4 I	1.0	1.0	0.0	0.0	.5	1.0	1.0
5 I	1.0	1.0	0.0	.5	0.0	1.0	1.0
6 I	1.0	1.0	0.0	0.0	0.0	0.0	.5
7 I	1.0	1.	[illegible]	0.0	0.0	.5	0.0

SUB-LIST SELF EVALUATION FREQUENCY MATRIX   EXAMPLE PROB NO 4, 5J X7A, COMPLETE,JUDGE SELF EVAL(40% THLD),MULT WTS

JUDGE 3   3 > 4 = 5 > 6 = 7 > 1 > 2

REDUCED MATRIX

PROJ	1	2	3	4	5	6	7
1 I	0.00	1.0	0.0	0.00	0.00	0.00	0.00
2 I	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 I	1.00	1.00	0.00	1.00	1.00	1.00	1.00
4 I	1.00	1.00	0.00	0.00	.50	1.00	1.00
5 I	.75	.75	0.00	.38	0.00	.75	.75
6 I	1.00	1.00	0.00	0.00	0.00	0.00	.50
7 I	.50	.50	0.00	0.00	0.00	.25	0.00

WEIGHTED SUB-LIST FREQUENCY MATRIX   EXAMPLE PROB NO 4, 5J X7A, COMPLETE,JUDGE SELF EVAL(40% THLD),MULT WTS

JUDGE 3

PROJ	1	2	3	4	5	6	7
1 I	0.0	32.0	0.0	0.0	0.0	0.0	0.0
2 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 I	54.0	64.0	0.0	64.0	64.0	64.0	64.0
4 I	16.0	16.0	0.0	0.0	6.0	16.0	16.0
5 I	12.0	12.0	0.0	6.0	0.0	12.0	12.0
6 I	64.	64.	0.0	0.0	0.0	0.0	32.0
7 I	8.0	8.0	0.0	0.0	0.0	4.0	0.0

TABLE D-5. (Continued)

SUB-LIST FREQUENCY MATRIX   EXAMPLE PROB NO 4, 5J X7A, COMPLETE,JUDGE SELF EVAL(40% THLD),MULT WTS

JUDGE 4   1 > 7 > 6 = 2 > 3 = 4 > 5

PROJ	1	2	3	4	5	6	7
1 I	0.0	1.0	1.0	1.0	1.0	1.0	1.0
2 I	0.0	0.0	1.0	1.0	1.0	.5	[illegible]
3 I	0.0	.5	0.0	.5	1.0	0.0	0.0
4 I	0.0	0.0	.5	0.0	1.0	0.0	0.0
5 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 I	0.0	.5	1.0	1.0	1.0	0.0	0.0
7 I	0.0	1.0	1.0	1.0	1.0	1.0	0.0

SUB-LIST SELF EVALUATION FREQUENCY MATRIX   EXAMPLE PROB NO 4, 5J X7A, COMPLETE,JUDGE SELF EVAL(40% THLD),MULT WTS

JUDGE 4   1 > 7 > 6 = 2 > 3 = 4 > 5

REDUCED MATRIX

PROJ	1	2	3	4	5	6	7
1 I	[illegible]	.6	.5	.60	.60	.60	.60
2 I	0.00	0.00	.50	.50	.50	.25	0.00
3 I	0.00	0.00	0.00	.35	.70	0.00	0.00
4 I	0.00	0.00	.50	0.00	1.00	0.00	0.00
5 I	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6 I	0.00	.30	.60	.60	.60	0.00	0.00
7 I	0.00	.80	.80	.80	.80	.80	0.00

WEIGHTED SUB-LIST FREQUENCY MATRIX   EXAMPLE PROB NO 4, 5J X7A, COMPLETE,JUDGE SELF EVAL(40% THLD),MULT WTS

JUDGE 4

PROJ	1	2	3	4	5	6	7
1 I	0.0	9.5	9.6	9.6	9.6	9.6	9.6
2 I	0.0	0.0	8.0	8.0	8.0	4.0	0.0
3 I	0.0	0.0	0.0	11.2	22.4	0.0	0.0
4 I	0.0	0.0	4.0	0.0	8.0	0.0	0.0
5 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 I	[illegible]	9.5	19.2	19.2	19.2	0.0	0.0
7 I	0.0	6.4	6.4	6.4	6.4	6.4	0.0

TABLE D-5. (Continued)

SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 4, 5J X7A, COMPLETE, JUDGE SELF EVAL(40% THLD), MULT WTS

JUDGE 5 4 > 3 > 2 > 1 > 7 > 6

PROJ	1	2	3	4	5	6	7
1 I	0.0	0.0	0.0	0.0	0.0	1.0	1.0
2 I	1.0	0.0	0.0	0.0	0.0	1.0	1.0
3 I	1.0	1.	[illegible]	[illegible]	0.	1.0	1.0
4 I	1.0	1.0	1.0	0.0	0.0	1.0	1.0
5 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 I	[illegible]	0.	[illegible]	[illegible]	[illegible]	1.0	0.0

SUB-LIST SELF EVALUATION FREQUENCY MATRIX EXAMPLE PROB NO 4, 5J X7A, COMPLETE, JUDGE SELF EVAL(40% THLD), MULT WTS

JUDGE 5 4 > 3 > 2 > 1 > 7 > 6 > 0

REDUCED MATRIX

PROJ	1	2	3	4	5	6	7
1 I	0.00	0.0	0.0	[illegible]	0.00	1.00	1.00
2 I	1.00	0.00	0.00	0.00	0.00	1.00	1.00
3 I	.80	.80	0.00	0.00	0.00	.80	.80
4 I	1.00	1.00	1.00	0.00	0.00	1.00	1.00
5 I	0.0	0.0	0.0	[illegible]	[illegible]	0.00	0.00
6 I	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7 I	0.00	0.00	0.00	0.00	0.00	1.00	0.00

WEIGHTED SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 4, 5J X7A, COMPLETE, JUDGE SELF EVAL(40% THLD), MULT WTS

JUDGE 5

PROJ	1	2	3	4	5	6	7
1 I	0.0	0.0	0.0	[illegible]	[illegible]	8.0	8.0
2 I	8.0	0.0	0.0	0.0	0.0	8.0	8.0
3 I	12.8	12.8	0.0	0.0	0.0	12.8	12.8
4 I	4.0	4.0	4.0	0.0	0.0	4.0	4.0
5 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 I	0.	0.	[illegible]	[illegible]	[illegible]	0.0	0.0
7 I	0.0	0.0	0.0	0.0	0.0	4.0	0.0

TABLE D-5. (Continued)

SUMMED FREQUENCY MATRIX

EXAMPLE PROB NO 4, 5J X7A, COMPLETE, JUDGE SELF EVAL(40% THLD), MULT WTS

JUDGE INDIFFERENCE EXISTS

EQUIV ADJ BORDA	ADJ BORDA		1	2	3	4	5	6	7
-83.2	-20.8	1 I	0.0	41.6	9.6	9.6	9.6	17.6	17.6
-167.2	-41.8	2 I	8.0	0.0	8.0	14.4	8.0	18.4	14.4
417.6	104.4	3 I	76.8	76.8	0.0	75.2	86.4	76.8	75.8
-22.0	-5.5	4 I	20.0	20.0	8.0	0.0	16.0	22.4	22.4
-107.6	-26.9	5 I	12.0	12.0	0.0	6.0	0.0	12.0	12.0
97.6	24.4	6 I	64.[illegible]	73.6	19.2	19.2	35.2	0.0	48.0
-135.2	-33.8	7 I	8.0	14.4	6.4	6.4	6.4	14.4	0.0

ADJ BORDA 3 > 6 > 4 > 1 > 5 > 7 > 2

TABLE D-5. (Continued)

COMPUTED PREFERENCE MATRIX   EXAMPLE PROB NO 4, 5J X7A, COMPLETE,JUDGE SELF EVAL(40% THLC),MULT W

SUM		1	2	3	4	5	6	7
2.0	1 I	0.0	1.0	[illegible]	0.0	0.0	0.0	1.0
.5	2 I	0.0	0.0	0.0	0.0	0.0	0.0	.5
6.0	3 I	1.0	1.0	0.0	1.0	1.0	1.0	1.0
5.0	4 I	1.0	1.0	0.0	0.0	1.0	1.0	1.0
3.0	5 I	1.0	1.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4.0	6 I	1.0	1.0	0.0	0.0	1.0	0.0	1.0
.5	7 I	0.0	.5	0.0	0.0	0.0	0.0	0.0

PREF 3 > 4 > 6 > 5 > 1 > 2 = 7

NUMBER OF FRACTIONAL SUMS= 2

LOWER N= 7 KENDALL D = 0.00 ZETA = 1.0000 PROB THAT RANK ORDER NOT CONSISTANT = 0.00000

RANK ORDER CONSISTANT AT .05 LEVEL
RANK ORDER CONSISTANT AT .01 LEVEL

UPPER N= 7 KENDALL D = 0.00 ZETA = 1.0000 PROB THAT RANK ORDER NOT CONSISTANT = 0.00000

RANK ORDER CONSISTANT AT .05 LEVEL
RANK ORDER CONSISTANT AT .01 LEVEL

AVERAGE N= 7 KENDALL D = 0.00 ZETA = 1.0000 PROB THAT RANK ORDER NOT CONSISTANT = 0.00000

RANK ORDER CONSISTANT AT .05 LEVEL
RANK ORDER CONSISTANT AT .01 LEVEL

TABLE D-5. (Continued)

CONCORDANCE SUMMARY BY ELEMENT EXAMPLE PROB NO 4, 5J X7A, COMPLETE,JUDGE SELF EVAL(40% THLD),MULT WTS

UNWEIGHTED SUBLISTS

JUDGE		1	2	3	4	5	6	7
JUDGE 1	I	6.0	1.0	6.0	2.0	6.0	3.0	4.0
JUDGE 2	I	5.[illegible]	[illegible]	[illegible]	5.[illegible]	2.[illegible]	1.[illegible]	5.[illegible]
JUDGE 3	I	6.0	7.0	1.0	2.5	2.5	4.5	4.5
JUDGE 4	I	1.0	3.5	5.5	5.5	7.0	3.5	2.0
JUDGE 5	I	4.0	3.0	2.0	1.0	7.0	6.0	5.0
R(J)		22.0	13.5	19.5	16.0	24.5	10.0	20.5

MEAN = 20.00 SUM OF DEVIATIONS SQUARED = 45.00

SUM T = 14.00

KENDALLS COEFFICIENT OF CONCORDANCE = .071 M = 5 N = 7

RANK ORDER NOT CONSISTANT AT .05 LEVEL. CRITICAL S = 276.20
RANK ORDER NOT CONSISTANT AT .01 LEVEL. CRITICAL S = 343.80

TABLE D-5. (Continued)

CONCORDANCE SUMMARY BY ELEMENT   EXAMPLE PROB NO 4, 5J X7A, COMPLETE,JUDGE SELF EVAL(40% THLD),MULT

UNWEIGHTED SUBLISTS

JUDGE		1	2	3	4	5	6	7
ADJ BORDA	I	4.0	7.0	1.0	3.0	5.0	2.0	6.0
PREF	I	5.0	6.5	1.0	2.0	4.0	3.0	6.5
R(J)		9.0	13.5	2.0	5.0	9.0	5.0	12.5

MEAN = 8.00   SUM OF DEVIATIONS SQUARED = 106.50

SUM T = .50

KENDALLS COEFICIENT OF CONCORDANCE = .959   M = 2   N = 7

RANK ORDER   CONSISTANT AT .05 LEVEL. CRITICAL S = 97.00
RANK ORDER   CONSISTANT AT .01 LEVEL. CRITICAL S = 104.00

TABLE D-5. (Concluded)

EXAMPLE PROB NO 4, 5J X7A, COMPLETE,JUDGE SELF EVAL(4.% THLD),MULT WTS

PREFERENCE RANK ORDER SUMMARY

ELEMENT INDEX RANK ORDER
3 > 4 > 6 > 5 > 1 > 2 = 7

RANK	PROJECT
1	PROJ C
2	PROJ D
3	PROJ F
4	PROJ E
5	PROJ A
6	PROJ B
6	PROJ G

TABLE D-6.

TECHNOLOGY PLANNING PRIORITIES EXAMPLE PROJ NO 5 EJ X7A, COMPLETE/W REQUIREMENTS TRANSLATION

NWT= 0 NPTYP1= 0 NPTYP2= 0 MATR= 0 THLD=0.00 NPRINT= 0

INPUT READ IN PROJECTS

INDEX	ELEMENT NAME	WT	CAT
1	PES -01	0.	0
2	PES -02	0.	0
3	PES -03	0.	[illegible]
4	PES -04	0.	0
5	PES -05	0.	0
6	PES -06	0.	0
7	PES -07	0.	0
[illegible]	END	0.	0

TABLE D-6. (Continued)

```
EXAMPLE PROB NO 5  5J X7A, COMPLETE/W REQUIREMENTS TRANSLATION

JUDGE 1        JCONV =    0    JUDGE WEIGHT =   0.0    JSE VALUE LIMIT =    0
TOTAL NBR ALT =    7     NR THIS JUDGE =    1

   1 >  2 >  3 >  4 >  5 >  6 >  7

JUDGE 2        JCONV =    0    JUDGE WEIGHT =   0.0    JSE VALUE LIMIT =    0
TOTAL NBR ALT =    7     NR THIS JUDGE =    2

   7 >  2 =  4 >  3 =  1 >  6 >  5

JUDGE 3        JCONV =    0    JUDGE WEIGHT =   0.0    JSE VALUE LIMIT =    0
TOTAL NBR ALT =    7     NR THIS JUDGE =    3

   3 >  4 =  5 >  5 =  7 >  1 >  2

JUDGE 4        JCONV =    0    JUDGE WEIGHT =   0.0    JSE VALUE LIMIT =    0
TOTAL NBR ALT =    7     NR THIS JUDGE =    4

   1 >  7 >  5 =  2 >  3 =  4 >  5
INPUT READ IN REQUIREMEN
```

TABLE D-6. (Continued)

INDEX	ELEMENT NAME	WT	CAT
1	R204.	0.	0
2	R301.	0.	0
3	R302.00A2	0.	0
4	R302.00E2	0.	0
5	R305.00F	0.	0
6	R306.	0.	0
7	R401.00A	0.	0
8	R401.00B	0.	0
9	R401.00G	0.	0
10	R401.00H	0.	0
11	R401.00I	0.	0
12	R401.00K	0.	0
13	R401.00N	0.	0
14	R601.	0.	0
15	R604.	0.	0
16	R605.	0.	0
0	END	0.	0

EXAMPLE PROB NO 5 5J X7A, COMPLETE/W REQUIREMENTS TRANSLATION

JUDGE 5   JCONV = 0   JUDGE WEIGHT = 0.0   JSE VALUE LIMIT = 0

TOTAL NBR ALT = 16   NR THIS JUDGE = 5

6 > 14 > 1 > 3 > 4 > 5 > 16

SUBLIST IS INCOMPLETE

TABLE D-6. (Continued)

INDEX LIST OF REQUIREMENTS AND PROJECTS

1	R101.	PGD -58	/	2	R101.	PGD -59	/	3	R101.	PGD -60	/	4	R101.	PGD -61	/
5	R101.	PGD -62	/	6	R101.	PGD -63	/	7	R101.	PGD -64	/	8	R101.	PGD -65	/
9	R101.	PGD -65	/	10	R101.	PGD -67	/	11	R101.	PGD -68	/	12	R101.	PGD -69	/
13	R101.	PGD -70	/	14	R101.	PGD -71	/	15	R109.	PGD -69	/	16	R204.	PES -02	/
17	R204.	PES -04	/	18	R213.	PET -46	/	19	R213.	PET -53	/	20	R301.	PDS -51	/
21	R301.	PDS -82	/	22	R301.	PES -01	/	23	R301.	PES -02	/	24	R301.	PES -04	/
25	R301.	PES -05	/	26	R301.	PES -06	/	27	R301.	PES -07	/	28	R301.	PES -09	/
29	R301.	PES -11	/	30	R301.	PES -12	/	31	R301.	PES -13	/	32	R301.	PES -15	/
33	R301.	PES -16	/	34	R301.	PET -45	/	35	R301.	PET -46	/	36	R301.	PET -47	/
37	R301.	PET -48	/	38	R301.	PET -49	/	39	R301.	PET -51	/	40	R301.	PET -52	/
41	R301.	PET -53	/	42	R301.	PGD -58	/	43	R301.	PGD -59	/	44	R301.	PGD -60	/
45	R301.	PGD -61	/	46	R301.	PGD -62	/	47	R301.	PGD -63	/	48	R301.	PGD -64	/
49	R301.	PGD -65	/	50	R301.	PGD -66	/	51	R301.	PGD -67	/	52	R301.	PGD -68	/
53	R301.	PGD -69	/	54	R301.	PGD -70	/	55	R301.	PGD -71	/	56	R301.	PGG -17	/
57	R301.	PGG -18	/	58	R301.	PGG -19	/	59	R301.	PGG -20	/	60	R301.	PGG -21	/
61	R301.	PGG -22	/	62	R301.	PGG -24	/	63	R301.	PGG -25	/	64	R301.	PGG -26	/
65	R301.	PGG -27	/	66	R301.	PGG -28	/	67	R301.	PGG -29	/	68	R301.	PGG -30	/
69	R301.	PGG -31	/	70	R301.	PGG -32	/	71	R301.	PGG -33	/	72	R301.	PGG -34	/
73	R301.	PGG -35	/	74	R301.	PGG -37	/	75	R301.	PGG -38	/	76	R301.	PGG -39	/
77	R301.	PGG -40	/	78	R301.	PGG -41	/	79	R301.	PGG -42	/	80	R301.	PGG -43	/
81	R301.	PGG -44	/	82	R301.	PKP -83	/	83	R301.	PKP -84	/	84	R301.	PKP -85	/
85	R301.	PKP -86	/	86	R301.	PKP -89	/	87	R302.00E2	PES -01	/	88	R302.00E2	PDS -70	/
89	R302.00E2	PES -05	/	90	R302.00E2	PES -07	/	91	R302.00E2	PES -10	/	92	R302.00E2	PES -16	/
93	R302.00E2	PGG -25	/	94	R302.00E2	PGG -27	/	95	R302.00E2	PGG -33	/	96	R302.00E2	PGG -38	/
97	R303.	PET -49	/	98	R303.	PGG -32	/	99	R304.	PES -09	/	100	R304.	PKP -83	/
101	R305.00F	PDS -79	/	102	R305.00F	PES -05	/	103	R305.00F	PES -07	/	104	R305.00F	PES -09	/
105	R305.00F	PES -10	/	106	R305.00F	PKP -87	/	107	R305.00F	PKP -90	/	108	R305.00F	PKP -91	/
109	R305.00F	PKP -93	/	110	R306.	PES -04	/	111	R307.	PKP -87	/	112	R307.	PKP -90	/
113	R307.	PKP -91	/	114	R307.	PKP -93	/	115	R307.	PKP -95	/	116	R310.00I	PES -16	/
117	R310.00I	PGG -25	/	118	R310.00I	PGG -27	/	119	R310.00I	PGG -33	/	120	R310.00I	PGG -38	/
121	R310.00K	PES -15	/	122	R310.00K	PGG -25	/	123	R310.00K	PGG -27	/	124	R310.00K	PGG -33	/
125	R310.00K	PGG -39	/	126	R313.00A	PENG-56	/	127	R401.00A	PES -02	/	128	R401.00A	PES -04	/
129	R401.00B	PES -02	/	130	R401.00B	PES -04	/	131	R401.00G	PES -02	/	132	R401.00G	PES -04	/
133	R401.00H	PDS -81	/	134	R401.00H	PDS -82	/	135	R401.00H	PES -02	/	136	R401.00H	PES -04	/
137	R401.00H	PES -05	/	138	R401.00H	PET -46	/	139	R401.00H	PET -47	/	140	R401.00H	PET -48	/
141	R401.00H	PET -53	/	142	R401.00H	PGD -58	/	143	R401.00H	PGD -59	/	144	R401.00H	PGD -60	/
145	R401.00H	PGD -61	/	146	R401.00H	PGD -62	/	147	R401.00H	PGD -63	/	148	R401.00H	PGD -64	/
149	R401.00H	PGD -65	/	150	R401.00H	PGD -66	/	151	R401.00H	PGD -67	/	152	R401.00H	PGD -68	/
153	R401.00H	PGD -69	/	154	R401.00H	PGD -70	/	155	R401.00H	PGD -71	/	156	R401.00H	PGG -19	/
157	R401.00H	PGG -20	/	158	R401.00H	PGG -21	/	159	R401.00H	PGG -22	/	160	R401.00H	PGG -24	/
161	R401.00H	PGG -26	/	162	R401.00H	PGG -29	/	163	R401.00H	PGG -32	/	164	R401.00H	PGG -34	/
165	R401.00H	PGG -35	/	166	R401.00H	PGG -37	/	167	R401.00H	PGG -39	/	168	R401.00H	PGG -40	/
169	R401.00H	PGG -41	/	170	R401.00H	PGG -42	/	171	R401.00H	PGG -43	/	172	R401.00H	PGG -44	/
173	R401.00H	PKP -84	/	174	R401.00H	PKP -85	/	175	R401.00H	PKP -86	/	176	R401.00H	PKP -91	/
177	R401.00I	PES -02	/	178	R401.00I	PES -04	/	179	R401.00K	PES -02	/	180	R401.00K	PES -04	/
181	R401.00N	PES -02	/	182	R401.00N	PES -04	/	183	R402.	PET -50	/	184	R404.	PDS -72	/
185	R404.	PGG -21	/	186	R404.	PGG -26	/	187	R404.	PGG -29	/	188	R404.	PGG -34	/

TABLE D-6. (Continued)

189	R404.	PGG -35	/ 190	R404.	PGG -40	/ 191	R404.	PGG -42	/ 192	R404.	PGG -44	/
193	R405.	PEHG-55	/ 194	R405.	PEHG-57	/ 195	R601.	PDS -81	/ 196	R601.	PDS -82	/
197	R601.	PES -03	/ 198	R601.	PES -08	/ 199	R601.	PGG -23	/ 200	R601.	PGG -24	/
201	R601.	PKP -86	/ 202	R601.	PKP -94	/ 203	R602.	PDS -75	/ 204	R602.	PDS -76	/
205	R602.	PDS -77	/ 206	R602.	PDS -80	/ 207	R602.	PES -08	/ 208	R602.	PES -09	/
209	R602.	PET -54	/ 210	R603.	PGD -58	/ 211	R603.	PGD -59	/ 212	R603.	PGD -60	/
213	R603.	PGD -61	/ 214	R603.	PGD -62	/ 215	R603.	PGD -63	/ 216	R603.	PGD -64	/
217	R603.	PGD -65	/ 218	R603.	PGD -66	/ 219	R603.	PGD -67	/ 220	R603.	PGD -68	/
221	R603.	PGD -69	/ 222	R603.	PGD -70	/ 223	R603.	PGD -71	/ 224	R604.	PDS -73	/
225	R604.	PDS -74	/ 226	R604.	PDS -60	/ 227	R604.	PES -03	/ 228	R604.	PES -14	/
229	R604.	PGG -23	/ 230	R604.	PGG -31	/ 231	R606.	PES -06	/ 232	R606.	PES -07	/
233	R605.	PES -14	/ 234	R607.	PEHG-56	/ 235	R607.	PET -54	/ 236	R609.	PEHG-56	/
237	R609.	PES -09	/ 238	R609.	PES -11	/ 239	R609.	PET -49	/ 240	R609.	PET -54	/
241	R609.	PKP -83	/ 242	R609.	PKP -84	/ 243	R609.	PKP -85	/ 244	R609.	PKP -92	/
245	R610.	PET -50	/ 246	R612.	PGG -31	/ 247	R612.	PGG -41	/ 248	R612.	PGG -43	/
249	R615.	PKP -89	/ 250	R616.	PKP -94	/ 251	R701.8	PGD -58	/ 252	R802.	PGD -59	/
253	R301.	PKP -95	/ 254	R301.	PGG -35	/						

REQUIREMENTS TO PROJECTS TRANSLATION

4 = 3 > 2 > 1 = 5 = 7 > 6

TABLE D-6. (Continued)

SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 5 5J X7A, COMPLETE/W REQUIREMENTS TRANSLATION

JUDGE 1 1 > 2 > 3 > 4 > 5 > 6 > 7

PROJ		1	2	3	4	5	6	7
1	I	0.0	1.	1.0	1.0	1.0	1.0	1.0
2	I	0.0	0.0	1.0	1.0	1.0	1.0	1.0
3	I	0.0	0.0	0.0	1.0	1.0	1.0	1.0
4	I	0.0	0.0	0.0	0.0	1.0	1.0	1.0
5	I	[illegible]	0.	[illegible]	[illegible]	0.0	1.0	1.0
6	I	[illegible]	0.0	0.0	0.0	0.0	0.0	1.0
7	I	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE D-6. (Continued)

SUB-LIST FREQUENCY MATRIX   EXAMPLE PROB NO 5 5J X7A, COMPLETE/W REQUIREMENTS TRANSLATION

JUDGE 2   7 > 2 = 4 > 3 = 1 > 6 > 5

PROJ	1	2	3	4	5	6	7
1 I	[illegible]	[illegible]	.5	0.0	1.0	1.0	0.0
2 I	1.0	0.0	1.0	.5	1.0	1.0	0.0
3 I	.5	0.0	0.0	0.0	1.0	1.0	0.0
4 I	1.0	.5	1.0	0.0	1.0	1.0	0.0
5 I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6 I	0.0	0.0	0.0	0.0	1.0	0.0	0.0
7 I	1.0	1.0	1.0	1.0	1.0	1.0	0.0

TABLE D-6. (Continued)

SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 5 5J X7A, COMPLETE/W REQUIREMENTS TRANSLATION

JUDGE 3 3 > 4 = 5 > 6 = 7 > 1 > 2

PROJ		1	2	3	4	5	6	7
1	I	0.0	1.	0.0	0.0	0.0	0.0	0.0
2	I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	I	1.0	1.0	0.0	1.0	1.0	1.0	1.0
4	I	1.0	1.0	0.0	0.0	.5	1.0	1.0
5	I	1.0	1.	0.0	.5	0.0	1.0	1.0
6	I	1.0	1.0	0.0	0.0	0.0	0.0	.5
7	I	1.0	1.0	0.0	0.0	0.0	.5	0.0

TABLE D-6. (Continued)

SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 5 5J X7A, COMPLETE/W REQUIREMENTS TRANSLATION

JUDGE 4 1 > 7 > 6 = 2 > 3 = 4 > 5

PROJ	1	2	3	4	5	6	7
1 I	0.0	1.	1.0	1.0	1.0	1.0	1.0
2 I	0.0	0.0	1.0	1.0	1.0	.5	0.0
3 I	0.0	0.0	0.0	.5	1.0	0.0	0.0
4 I	0.0	0.0	.5	0.0	1.0	0.0	0.0
5 I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.6
6 I	0.0	.5	1.0	1.0	1.0	0.0	0.0
7 I	0.0	1.0	1.0	1.0	1.0	1.0	0.0

TABLE D-6. (Continued)

SUB-LIST FREQUENCY MATRIX EXAMPLE PROB NO 5 5J X7A, COMPLETE/W REQUIREMENTS TRANSLATICN

JUDGE 5 4 = 3 > 2 > 1 = 5 = 7 > 6

PROJ	1	2	3	4	5	6	7
1 I	0.0	0.	0.0	0.0	.5	1.0	.5
2 I	1.0	0.0	0.0	0.0	1.0	1.0	1.0
3 I	1.0	1.0	0.0	.5	1.0	1.0	1.0
4 I	1.0	1.0	.5	0.0	1.0	1.0	1.0
5 I	.5	0.	0.0	0.0	0.0	1.0	.5
6 I	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 I	.5	0.0	0.0	0.0	.5	1.0	0.0

TABLE D-6. (Continued)

SUMMED FREQUENCY MATRIX EXAMPLE PROB NO 5 5J X7A, COMPLETE/W REQUIREMENTS TRANSLATION

JUDGE INDIFFERENCE EXISTS

ADJ BORDA		1	2	3	4	5	6	7
5.0	1 I	0.0	3.0	2.5	2.0	3.5	4.0	2.5
4.0	2 I	2.0	0.0	3.0	2.5	4.0	3.5	2.0
9.0	3 I	2.5	2.0	0.0	3.0	5.0	4.0	3.0
8.0	4 I	3.0	2.5	2.0	0.0	4.5	4.0	3.0
-13.0	5 I	1.5	1.0	0.0	.5	0.0	3.0	2.5
-14.0	6 I	1.0	1.5	1.0	1.0	2.0	0.0	1.5
1.0	7 I	2.5	3.0	2.0	2.0	2.5	3.5	0.0

ADJ BORDA 3 > 4 > 1 > 2 > 7 > 5 > 6

TABLE D-6. (Continued)

COMPUTED PREFERENCE MATRIX   EXAMPLE PROB NO 5 5J X7A, COMPLETE/W REQUIREMENTS TRANSLATION

SUM		1	2	3	4	5	6	7
4.0	1 I	0.0	1.0	.5	0.0	1.0	1.0	.5
3.5	2 I	0.0	0.0	1.0	.5	1.0	1.0	0.0
4.5	3 I	.5	0.0	0.0	1.0	1.0	1.0	1.0
4.5	4 I	1.0	.5	0.0	0.0	1.0	1.0	1.0
1.5	5 I	0.0	0.0	0.0	0.0	0.0	1.0	.5
[illegible]	6 I	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.0
3.0	7 I	.5	1.0	0.0	0.0	.5	1.0	0.0

PREF   3 = 4 > 1 > 2 > 7 > 5 > 6

NUMBER OF FRACTIONAL SUMS= 4

LOWER N= 7 KENDALL D = 4.00 ZETA = .7143 PROB THAT RANK ORDER NOT CONSISTANT = .03335714

RANK ORDER CONSISTANT AT .05 LEVEL
RANK ORDER NOT CONSISTANT AT .01 LEVEL

UPPER N= 7 KENDALL D = 6.00 ZETA = .5714 PROB THAT RANK ORDER NOT CONSISTANT = .11268254

RANK ORDER NOT CONSISTANT AT .05 LEVEL
RANK ORDER NOT CONSISTANT AT .01 LEVEL

AVERAGE N= 7 KENDALL D = 5.00 ZETA = .6429 PROB THAT RANK ORDER NOT CONSISTANT = .06908652

RANK ORDER NOT CONSISTANT AT .05 LEVEL
RANK ORDER NOT CONSISTANT AT .01 LEVEL

TABLE D-6. (Continued)

~~CONCORDANCE~~ SUMMARY BY ELEMENT EXAMPLE PROJ NO 5 5J X7A, COMPLETE/W REQUIREMENTS TRANSLATION
UNWEIGHTED SUBLISTS

JUDGE		1	2	3	4	5	6	7
~~ADJ BORDA~~	I	3.0	4.0	~~1.0~~	2.0	6.0	7.[illegible]	5.[illegible]
PREF	I	3.0	4.0	1.5	1.5	6.0	7.0	5.0
R(J)		6.0	8.0	2.5	3.5	12.0	14.0	10.0

MEAN = 8.00 SUM OF DEVIATIONS SQUARED = 110.5

SUM T = .50

KENDALLS COEFICIENT OF CONCORDANCE = .995 M = 2 N = 7

RANK ORDER CONSISTANT AT .05 LEVEL. CRITICAL S = 97.00
~~RANK ORDER CONSISTANT AT .01 LEVEL. CRITICAL S = 104.00~~

TABLE D-6. (Concluded)

EXAMPLE PROB NO 5 5J X7A, COMPLETE/W REQUIREMENTS TRANSLATION

PREFERENCE RANK ORDER SUMMARY

ELEMENT INDEX RANK ORDER
3 = 4 > 1 > 2 > 7 > 5 > 6

RANK	PROJECT
1	PES -03
1	PES -04
2	PES -01
3	PES -02
4	PES -07
5	PES -05
6	PES -06

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